THE SCIENCE AND ART OF JOINT MANIPULATION

Also by Dr. J. B. Mennell

THE SCIENCE AND ART OF JOINT MANIPULATION
Vol. II. The Spinal Column
In preparation.

PHYSICAL TREATMENT: By Movement, Manipulation and Massage
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THE

SCIENCE AND ART

OF

JOINT MANIPULATION

By

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and

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Awarded the Golden Keys with Life Membership of The American Congress of Physical Medicine

and

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VOL I—THE EXTREMITIES

SECOND EDITION

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Second Edition . . . 1949

PREFACE TO THE SECOND EDITION

FORTUNATELY for me there has been a number of readers sufficiently interested to offer kindly but constructive criticisms of the first edition, which have helped me very much indeed in the preparation of this Second Edition, although they have added considerably to the amount of work involved This, however, has not increased the size of the book materially, as it has only been necessary to add three new and two alternative techniques in the form of short additions Two concern the manipulation of the shoulder joint and one concerns that of the joints of the cuboid

The criticisms have been mainly verbal, drawing my attention to obscure passages where comparatively small alteration has, I hope, improved the clarity of description

To one of my correspondents (personally unknown to me), I owe nine useful suggestions of this type and these came from a practising osteopath, L W J Gable, D R O these suggestions have been adopted, with a single exception

With regard to illustrations, the number has been increased slightly owing, among other things, to the necessity for adding pictorial aid to explain the additional manipulations of the shoulder Six of the X-ray photographs of the shoulder region have been replaced as they showed insufficiently clearly the points that I wished to raise In the first edition they were not adequate to carry the conviction that I had hoped they might do The substitutes which will, I hope, be more convincing, I owe to the courtesy of Dr Ray Carter, of the County Hospital, Los Angeles, and his assistants

For the rest, the many to whom I owe valuable help and assistance are again those who helped me with the first edition and I can only hope that once again our united labours will receive the same appreciation that greeted our first effort

The new illustrations and the new X-ray photos, I owe to the willing, courteous and ever-ready co-operation of my new colleagues in the University of Southern California Foremost amongst these was Dr O Leonard Huddleston, at that time Professor of Physical Medicine in the University Without his help and collaboration and that of his staff, the publication of this edition must have remained indefinitely postponed

The additional drawing of Mrs Guthrie Smith's apparatus, I owe to the kindly help and co-operation of Miss K Bier, A S P, and my readers and myself alike owe a deep debt of gratitude to Miss J D Dennison, C S P, for arranging again all cross-references and numerals in connection with the illustrations as well as for valuable help in seeing the MS through the printer's hands

My time for literary efforts is very strictly limited and I have had an amount of writing and of film work to do Still, I was able to start upon it during last year, and I hope that it should not take many months to produce The text will not present great difficulties, but drawings, X-ray photographs and photographs illustrating technique, if they are to be of any service at all, absorb an immense amount of time Present prospects are that it should be ready towards the end of 1949

Once more I owe a big debt of gratitude to my publishers for their kindly patience and help in many other ways It has not been easy for anyone concerned to be over 6,000 miles apart My main hope has rested on Mr J Rivers, Managing Director, and not without justification He has also been kind enough again to deal with the Index

I would like to add that the Preface to the first edition contains much that may be of value to the reader of the second

JAMES MENNELL

Pasadena, 15,
California, *U S A*

PREFACE TO THE FIRST EDITION

THE history of this monograph may be of some interest. I had con-emplated for a short time the possibility of writing it when I showed some f the X-ray photographs here reproduced at a meeting of the Physical Iedicine Section of the Royal Society of Medicine in May, 1933. Very soon became overwhelmed with the difficulties in front of me and it seemed so nuch more simple to show the manipulations on a film. Then, having been n close touch with the members of the Chartered Society since 1907 or 908, I have long realised that joint manipulation should form an essential part of their daily routine; yet there was no standard teaching in this pecial part of their work and, therefore, no questions were permissible in heir examinations. Thus most of them passed out into the world with a neagre, if any, knowledge of the special art of joint manipulation. In the nope that I might be able to give as wide publicity as possible to the technique I employ, and also that I might set a standard for teaching and examination, I had the film made. This proved as difficult a task—and perhaps more so—than the one I had abandoned; but, having started, I saw the matter through, and the film is now in the possession of the Society.

Again I was doomed to disappointment: it is not a "talkie," and without explanation it is well-nigh useless. Then, very reluctantly, I realised that I must supply the deficiency, hence this outcome of thought in book form. Yet now, on reading through the page-proofs, there is borne home to me the precept that was so well dinned into me as a boy: "Whist begins where Cavendish ends." Yet "Cavendish on Whist" made scientific whist a possibility: and so I hope "James Mennell on Joint Movements" will render the art of manipulation a scientific possibility, too—and a fascinating game it is, even though the art may be difficult to acquire.

Thus the following pages must not be taken as the be-all and end-all of manipulative work. Rather have I tried to select hard and fast rules from an educational standpoint as the rock foundation on which to build. For this reason I have rarely suggested alternative methods for the manipulation of any one joint, though I am conscious of numberless varieties in my own practice to suit the needs of individual cases: no two are exactly alike and each therefore calls for addition to, but not modification of, the basic laws. Still the difficulties in learning the technique of the art are so great, that I am sure that it is wise to try to set a manual standard, and then, when this has been mastered—but then only—may the student of the art be considered competent to work out variations on the basic themes and principles. My hope, therefore, is first that my fellow-practitioners may find in these pages the guidance necessary to render treatment by manipulation a standard

one, rather than, as is so often the case at present, a matter of the haphazard application of brute force. Of the latter there is no need; force can never replace technique save to the great disadvantage of the patient. Then, second, I hope that the teachers in the training schools recognised by the Chartered Society will now feel that they have a standard text-book which will justify them in preparing students for work in this special branch of their profession, and that, ultimately, it may be possible to regard the teaching of manipulation as being so general, that it may become officially a fit subject for inclusion in the Society's training and examinations.

Perhaps I may be asked why it is that little or no distinction is drawn in these pages between joint examination and the treatment of disordered function within joints; and also why only incidental reference—it may even seem almost accidental—is made to the treatment of specific conditions, *e.g.*, tennis elbow, golfer's wrist, bowler's (or pitcher's) shoulder, footballer's knee, hiker's foot and so forth. The answer to these questions seems to be a simple one. All medical treatment is, or should be, based on the establishment of a diagnosis, and if we wish to do this with regard to the function of any joint, it is essential to examine every movement that can possibly take place at that joint, be it under voluntary control or no. In other words, no examination of a joint can be considered complete until every movement described in the following pages has been examined with meticulous care. Often enough it is essential to avoid the examination of some one or more movements, for fear of increasing within the joint the condition which we hope to remedy, but the fact that the movement has been considered, and is noted as unsuitable, will serve as a very valuable guide when the question of treatment is under consideration. Still the fact remains that unless all movements have been examined, whether or no they are under voluntary control (even though the examination leads to the conclusion that it is ill-advised to manipulate the joint at all), no examination of any joint can be considered as complete. Thus the technique for examination and for treatment is identical, with the one exception, that examination omits the administration of the final impressed force, which is calculated to aid the restoration of normality with regard to any function that is found to be imperfect.

With regard to the omission of references to certain specific conditions, it is always well to remember that just as it is one thing to say that a patient has been cured, it is quite another to say what has effected the cure; so, too, it is one thing to say that a condition arose, perhaps, after the performance of some movement, and another to say that the movement was responsible for causing the symptoms. As I have stated so often when writing or lecturing, the recuperative power of Nature always tends strongly towards recovery, and so potent is it that often enough recovery takes place in spite of our treatment and not because of it. Yet the facts remain that our treatment may be sufficiently bad as not to allow Nature to carry on the beneficent work of recuperation to the best advantage; while on the other hand we may well be able to make ultimate cure possible, to assist in the

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Then, too, the ostensible cause may not be the true cause of disordered ion in a joint. Take, for example, a so-called "tennis elbow." True, ain may start during or after a game of tennis, but the patient may slipped or fallen and the cause of the "tennis elbow" may well be due e fall, not to the game at all. Again, a tennis player may have an ss at the root of a tooth or tonsil; the ordinary resistance of the body be adequate to prevent spread of the infection, but not to do so under rmal conditions of movement or strain. A local infective process may t up, perhaps a sensitive deposit is formed in the origin of the extensor les and the symptoms of so-called "tennis elbow" are then established.

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treatment for various named—and often mis-named—complaints It seemed better to describe the methods to be adopted in joint examination and then to indicate how the application of the remedial force can be administered I hope that, by treating the subject in this manner, I may have been able to save some patients from manipulation when other remedies are more calculated to prove successful in bringing relief On the other hand, if these pages succeed in their dual object of rendering joint manipulation accessible to those cases for which it is applicable, and of establishing a technique based on scientific laws, my objective will have been attained

One point remains which I am told, may require explanation On several occasions reference has been made to "taking up the slack"—a nautical expression which I presumed to be a matter of common parlance I am told that many people, and particularly should any seek to translate it, may be in doubt as to the exact meaning The reference is to a rope on a boat Movement of the boom may cause the rope that controls it to slacken and traction is then placed upon it until it is taut once more It may be necessary to repeat the process time after time, always patiently awaiting opportunity The same thing applies to a hawser that fastens the boat to the dock It may appear to be as taut as it can be pulled, but slowly the boat may swing inwards a little and traction soon "takes up the slack" and once more the line is taut It is a slow, gradual process, force plays no part Applied to a joint the process indicated is merely a question of waiting patiently for an alteration to take place which allows an increase in the range of movement After a variable length of time the limit of anatomical and physiological (or pathological) movement is reached, and it is then that the mobilising impressed force may be exerted to restore the full functional range of movement This "taking up the slack" is in itself a special art, yet it is an essential part of treatment by manipulation which calls for accurate knowledge of the uttermost limit of the normal movements and of the extent to which the normal function fails to be perfected

Only one more point It is comparatively easy to learn the science of joint manipulation, but the technique of applying the art is by no means so simple It is difficult to teach it is difficult to learn and prolonged practice is the only means of attaining perfection

In the preparation of a book of this type the author must of necessity rely for help upon a large number of people I would recall the immense debt of gratitude that not only I, but those who read the following pages owe to Mr H C Streatfeild, C I E, who without any technical knowledge whatever, has shepherded the letterpress through from beginning to end—manuscript, slip-proof and page-proof While dealing with the manuscript it was not at all uncommon for him even to take paragraph by paragraph and re-write it in his own hand in a form which he, as a layman, would better understand, and thus he has rendered it far less difficult for those with the technical knowledge to follow the argument and reasoning Time after time what appeared perfectly plain to me as I had originally written it has been

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Of the members of my staff who have served as models for illustrations I can only say that, in one way or another, the number that have rendered assistance is so great that I am afraid I cannot enumerate them. Taken in chronological order: Miss Catherine Lamb served as model during the preparation of the vast majority of the X-ray photographs. This was no mean task, and it meant giving up an immense amount of time. For other photographs I am mainly indebted to Miss J. D. Dennison, who gave freely of her scanty leisure to this tedious job. Some of the X-ray photographs were also taken with her serving in the capacity of model. Then, in addition, she has read the manuscript for me, has pointed out several errors that have crept in; and, where the revision has been too involved for ready understanding, she has pointed this out and thus enabled me to make final corrections. On many occasions my Secretary, Miss F. M. Porcheron, has come forward whenever help has been needed.

All the photographs and the X-ray plates were prepared in the X-ray Department at St. Thomas's Hospital, owing to the courtesy of Dr. Geoffrey Fildes; indeed, it was owing to his encouragement that I first thought of making the attempt to illustrate the effect of manipulation by means of reproduction of X-ray photographs. With the exception of half-a-dozen photos, which were done in the Isle of Wight, I owe them all to the untiring care and technical skill of Mr. H. E. Hardwicke and his son. For obvious reasons we could only work in the Department at St. Thomas's when it was empty, and this meant that they both had to come up on more Saturday afternoons and Sundays than I care to look back on in retrospect with placidity. How many exposures we made which proved unacceptable, and which, therefore, had to be repeated, I do not know; it would not surprise me if I found that it was 30 per cent. I often wonder if any other pair of helpers would have been so unfailingly courteous and patient with me. The end-result surely testifies to their skill and care.

For the sketches I am indebted to two artists, Miss M. J. J. Doucet, C.S.P.,[1] who broke the ice, and to Miss Ruth Scrivenor, who carried on with the good work following her example. Miss Mabel Lipscomb has also given further help. It may be asked, why were all these reproductions of well-known features necessary? It may be as well to point out that with two exceptions, which are acknowledged in the text, no actual reproductions were made. On superficial examination I have no doubt that these sketches would be thought to be identical with those to be found in the ordinary

[1] [illegible]

anatomical text-books. In gross outline, of course, this is true, but I found it was possible by altering the position of the bones to a minute extent, to show to better advantage the points that needed emphasis. Therefore, however closely some of these sketches may appear to resemble others that have been published elsewhere, some variations have been reproduced, each with a definite objective. It has been found necessary to revise many of these sketches three or four times before we were successful in showing the exact detail that was required, as it is not an easy task to try to indicate to the artistic eye, which has to reproduce what it sees, the points which, on purely anatomical grounds, I wish to demonstrate. I do not know where the technical difficulties may be, but I believe that one at least is that I wanted a view shown in two planes when the reproduction of necessity can only appear in one.

Finally, I feel that few people can have received more kindly consideration from their publishers than I have done during the preparation of this book, and the care that has been expended to render it as perfect as is reasonably possible has been to me a remarkable feat of combined skill and patience. Even preparing the Index has been a task of most unusual difficulty, but Mr J. Rivers,[1] who has helped me so unceasingly with the production, seems to me to have made a remarkable success of it.

My publishers have also allowed me to borrow freely from the illustrations of the two books that they had published for me previously, namely, "Physical Treatment by Movement, Manipulation and Massage" and "Backache." Specific ailments—such as those mentioned—are fully considered in the former volume.

PARK SQUARE EAST, N.W.1. JAMES MENNELL.

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All the photographs and the X-ray plates were prepared in the X-ray Department at St. Thomas's Hospital, owing to the courtesy of Dr. Geoffrey Fildes; indeed, it was owing to his encouragement that I first thought of making the attempt to illustrate the effect of manipulation by means of reproduction of X-ray photographs. With the exception of half-a-dozen photos, which were done in the Isle of Wight, I owe them all to the untiring care and technical skill of Mr. H. E. Hardwicke and his son. For obvious reasons we could only work in the Department at St. Thomas's when it was empty, and this meant that they both had to come up on more Saturday afternoons and Sundays than I care to look back on in retrospect with placidity. How many exposures we made which proved unacceptable, and which, therefore, had to be repeated, I do not know: it would not surprise me if I found that it was 30 per cent. I often wonder if any other pair of helpers would have been so unfailingly courteous and patient with me. The end-result surely testifies to their skill and care.

For the sketches I am indebted to two artists, Miss M. J. J. Doucet, C.S.P.,[1] who broke the ice, and to Miss Ruth Scrivenor, who carried on with the good work following her example. Miss Mabel Lipscomb has also given further help. It may be asked, why were all these reproductions of well-known features necessary? It may be as well to point out that with two exceptions, which are acknowledged in the text, no actual reproductions were made. On superficial examination I have no doubt that these sketches would be thought to be identical with those to be found in the ordinary

[illegible]

anatomical text-books In gross outline, of course, this is true, but I found it was possible by altering the position of the bones to a minute extent, to show to better advantage the points that needed emphasis Therefore, however closely some of these sketches may appear to resemble others that have been published elsewhere, some variations have been reproduced, each with a definite objective It has been found necessary to revise many of these sketches three or four times before we were successful in showing the exact detail that was required, as it is not an easy task to try to indicate to the artistic eye, which has to reproduce what it sees, the points which, on purely anatomical grounds, I wish to demonstrate I do not know where the technical difficulties may be, but I believe that one at least is that I wanted a view shown in two planes when the reproduction of necessity can only appear in one

Finally, I feel that few people can have received more kindly consideration from their publishers than I have done during the preparation of this book, and the care that has been expended to render it as perfect as is reasonably possible has been to me a remarkable feat of combined skill and patience Even preparing the Index has been a task of most unusual difficulty, but Mr J Rivers,[1] who has helped me so unceasingly with the production, seems to me to have made a remarkable success of it

My publishers have also allowed me to borrow freely from the illustrations of the two books that they had published for me previously, namely, "Physical Treatment by Movement, Manipulation and Massage" and "Backache" Specific ailments—such as those mentioned—are fully considered in the former volume

PARK SQUARE EAST, N W 1 JAMES MENNELL

[1] Now Managing Director of J and A Churchill Ltd

CONTENTS

PART I

GENERAL CONSIDERATIONS

CHAPTER I

INTRODUCTION

"Bone-setting" in this country is nothing new There are certain families in which a technique of manipulation for the relief of stiff or painful joints has been handed down from generation to generation from time immemorial The origin of this technique is lost in the mists of antiquity, and therefore the laws if any, on which the treatment was originally based are necessarily unknown The practitioners seldom received any sort of medical training, and usually their main work in life was something far removed from the treatment of the sick But that these hereditary bone-setters did actually convey definite physical benefit to many of those who consulted them is beyond all doubt, and it is quite impossible to attribute to psychological phenomena every case of cure or relief so effected

Unfortunately the unqualified bone-setter attributed his cures when they occurred, to phenomena which the qualified practitioner knew could only exist in the imagination Some spoke of dislocation where no dislocation was possible, others of a "little bone" being out of place, in a position where there was no "little bone," as anatomical knowledge could prove Then the untenable claim was made that such imaginary dislocations and displacements had been reduced or restored by manipulation The advent of X-ray examination has proved that, in the vast majority of cases in which claims of this type were made, no dislocation, as understood by the medical practitioner was in fact present

So much for the strictly medical point of view but there is a great deal to be said on behalf of the general belief in the claims of the bone-setter Let us take the case of a patient who had suffered a degree of incapacity, say in the wrist or elbow, owing to pain or even to a sudden sensation of weakness during certain movements Orthodox treatment having been tried and the patient having perhaps undergone the extreme inconvenience of splintage, with no improvement and possibly with actual deterioration of the condition, the patient visited the bone-setter who asserted that the little bone was out of place or that there was dislocation Manipulation was performed, and the patient was aware of unexpected movement in the region under treatment, and possibly also heard a definite snap or scrunch

real conception of what is meant by the term as scientifically used. All he knows is that a joint which does not move freely can be made to move under an anæsthetic, and the more intrepid practitioner will often carry out the manipulation without any training or knowledge to guide him. The result only too often is the abuse and not the use of the treatment, with the inevitable consequence that the treatment itself is condemned, whereas the real cause of the failure is lack of training and technique.

Osteopathy is a later development of the art of manipulation, and cheiropraxy slightly later still. The date usually given for the birth of osteopathy is 1874, and its father was Andrew Still—a qualified medical practitioner in America. The theory of cheiropraxis owed its origin to Palmer of Iowa some twenty years later. The two systems have this in common, that they both teach manipulation of the joints of the spine, including the sacroiliac joints, as the sovereign method of relieving symptoms, and also of maintaining general health.

The osteopath claims that the most important single factor in the production of all disease is the spinal lesion, and that, as a necessary corollary, the correction of this lesion is the most important single factor in the treatment of all disease. The "lesion" is variously described, but what is exactly understood by the term is perhaps best expressed merely by saying that it means "the immobilisation of a joint in a position of normal movement."[1] This would seem to imply a certain—though perhaps very limited—degree of locking or "seizing-up," or, perhaps best of all, "binding" of two joint surfaces, but this is not by any means the whole of the story, as the part played by the soft parts is often more important than that of the actual joint surfaces from the point of view of the disturbance of normal function. After all, if, from any cause, the fascial structures are not free to function in the manner intended by nature, it is impossible for the joints to do so. Perhaps the most commonly recognised example is the taut ilio-tibial band; but this is only one band of fascia in the human body, there are countless others, and assuredly they must all be subject, to a greater or less degree, to corresponding lack of perfection of function. There is much to be said in favour of the instinctive desire of the domestic dog and cat to stretch fully on waking from sleep as a sort of first duty in life.[1] There is more loss of function from taut fascial bands than is commonly recognised, and this may account for the all too common relapses that follow apparently successful joint manipulation.

The doctrine so commonly attached to the theory of the spinal lesion, when reduced to its elements, is this, that disordered function within a joint can so interfere with the circulation in extra-articular parts as to render them susceptible, as a result of the lowered vitality of the part, to every variety of ill. This lowered vitality not only paves the way for bacteriological invasion, but may also lead to a faulty functioning of the part or organ involved.

The belief of the cheiropractor is, to put it briefly, similar to that of the osteopath, save that the spinal lesion is held to exert its deleterious power by direct action on some element in the nervous system. It has been said

[1] Edythe F. Ashmore of Kirksville, Missouri, U.S.A.

accompanying the movement. The movement was probably associated with transitory and very trivial pain, and, as soon as this subsided, the patient enjoyed a freedom of movement long denied to him, and was free from further symptoms. In such a case one cannot wonder if the patient came to the conclusion either that, in spite of scientific knowledge and the evidence of X-ray examination, the bone-setter was right and the orthodox practitioner wrong, or that, although there had been no dislocation and no little bone out of place, relief had been obtained through some magical gift in the hands of the bone-setter. Yet the fact remains that the pain and disability of which the patient complained might have been due to the onset of an acute infective arthritis, or to the first symptoms of tuberculosis. Manipulation in either event might do irreparable harm. Far better is it that some should have been deprived unnecessarily of the enjoyment of a favourite game than that any should have risked limb or even life owing to untimely and unscientific administration of a remedy, of which all that can be said is that, had the cause of incapacity been other than it was, it might have brought relief.

Some bone-setters have claimed mystical power, or have invoked divine assistance for their manipulations, and since almost every human being has some sort of belief in a Supernatural Power, it was easy for the bone-setter who claimed magical powers to persuade those patients on whom successful movements had been performed that the miraculous had happened, and that some mystical gift had enabled him to "strike his hand over the place and recover the leper." In fact it is likely that at one period the hereditary bone-setter made a practice of "calling upon the name of the Lord his God" before performing his manipulation, a procedure which, it will be remembered, Naaman the Syrian expected of the prophet Elisha. This practice would not preclude the invocation by some form of incantation to the powers of evil as well.

The attitude of the orthodox medical practitioner toward the bone-setter, whether he claimed magical powers or whether he claimed, without such powers, to cure symptoms by removing conditions which scientific knowledge could prove to be non-existent, was of necessity one of profound distrust. It was obviously out of the question for him to countenance treatment based on a foundation which he knew to be fallacious.

There is nothing to show how far the bone-setter of times gone by applied his art to the joints of the spine as distinct from the joints of the extremities, but it is fairly certain that the joints of the cervical spine at any rate came under treatment and also the sacro-iliac joints.

From the foregoing it must not be understood that in bygone generations the regular practitioner was ignorant of, or entirely failed to practise, manipulative treatment. There is evidence that many medical men have regularly used this treatment, though until recent times descriptions of technique have not been passed on by these practitioners to their successors in the profession. Even to-day the technique or the art of joint manipulation forms no part of the medical curriculum, and the medical student is fortunate if he has any

manipulation, there is less difficulty with the hearing, although no appreciable alteration has in fact taken place The apparent improvement will induce the patient to persevere hopefully with the treatment and the hopeful attitude of mind in itself tends to convince him of further amelioration

Moreover, in Nature there is always some tendency towards healing and repair This is itself a tremendous asset to all treatments which claim curative properties, since, whatever the system of cure employed, there will always be a percentage of cases which will naturally tend towards recovery, often not because of, but in spite of, the treatment Treatment if sufficiently bad, will, of course, militate against recovery, but frequently a patient will tend towards recovery in spite of thoroughly unsuitable treatment In such cases the patient inevitably ascribes the improvement to the treatment, which in fact had nothing to do with it One good recent example is that of a patient with a short tendo Achillis who for four years had been unable to walk up or down stairs in comfort in spite of the fact that his main job in life was standing Alteration of his footgear at once enabled him to go up and down stairs with a freedom that he had not known for years He was grossly overweight His heart began to let him down and he was ordered complete rest from duty and a material reduction of weight At the end of two months his leg and foot symptoms had entirely disappeared, presumably as the result of manipulation, adjustment of foot-gear, rest and reduction of weight It so happened that he was ordered diathermy while in bed The *rationale* of this is not apparent Still nothing on earth will induce him to believe that anything but the diathermy has been the curative agency

There remains a percentage of cases where cure can be attributed entirely to faith, *i e*, the cures which are founded on purely psychological processes These cases can give to the unscrupulous manipulator a notable advantage If he can persuade his patient that symptoms, which are purely psychological, owe their origin to some disordered function within a joint, and if he can then produce an audible sound within the joint, combined with a sensation of unaccustomed movement he has most of the factors required for a so called "miracle cure" When speaking of psychological symptoms we must however, remember that, as those who deal largely in physical treatment very well know, neurasthenic and even hysterical symptoms may be associated with some degree of physical derangement, and this may be present in the form of a joint "lesion" As long as this derangement is allowed to persist there will be little or no progress in the battle against psychological exaggeration of the symptoms remove the physical foundation on which the psychological exaggeration rests and the psychological element will often disappear without further aid

Still when all has been said that may tend to explain away the benefit conferred by manipulation there remains an enormous mass of testimony that manipulative treatment has a real potentiality for good in a great variety of cases

In trying to arrive at a scientific explanation of this fact, two points call for special consideration First what do we mean by a joint lesion? and,

that the creed of the osteopath is based on the law of the artery, and that of the cheiropractor on the law of the nerve.

Few qualified medical practitioners have found themselves able to accept the doctrines—or perhaps better the creeds—of either the osteopath or the cheiropractor. Just as it was impossible for them to recommend treatment by bone-setting manipulation, when manipulation was based on an imaginary or scientifically false presentation of the conditions, so too, they were debarred from recommending osteopathic or cheiropractic manipulation when the *raison d'être* of the treatment was a creed in which they could not believe. At the same time it was indisputable that the exponents of both had brought help and relief to many patients in the past, after more orthodox treatment had been tried and failed.

This, then, was the dilemma which faced those medical practitioners who devoted themselves to the study of that branch of therapeutics which has now become generally known as Physical Medicine. On the one hand was the undoubted benefit received by countless patients as the result of manipulation by those outside the medical profession; on the other was the fact that those who practised the manipulation, based it on what was, to most medical men, a scientifically false creed. Manifestly it was right for medical practitioners to withhold from their patients treatment which might perhaps bring relief, while the theory which underlay the treatment was not based on known scientific fact. The problem to be solved was how far, if the claims made for manipulative treatment were investigated by those with adequate material and opportunity for the task, it would be possible to substitute a scientific basis of treatment for the existing untenable creeds.

One of the difficult elements in these investigations was the fact, well known to medical men, that in many cases unscientific manipulative treatment had resulted in definite and serious harm to the patient. Far from being a cure-all, in unsuitable cases it was attended with very real dangers. In other cases it seemed to have no effect either for good or evil, while in other cases again, covering a variety of complaints, patients undoubtedly seemed to benefit for a time and would then make no further progress, but might even find that deterioration set in with the cessation of treatment. Consideration of these facts led to the conclusion that there might well be a dual origin of the symptoms, and that manipulative treatment had brought an element of relief by adjusting one origin while leaving the other still operative. Take, for example, a case of "golf-wrist." Symptoms may arise from some disordered function in the joints of the carpal region and these symptoms may be amenable to manipulation. But in some cases a few fibres are ruptured in the flexor carpi ulnaris at the lower limit of the region of the origin of the muscle from the ulna: symptoms arising from this point would not probably be affected by manipulation either for good or evil. In a case of deafness, again, the patient may also be suffering from some degree of disordered function of the joints of the cervical spine, leading to discomfort referred along the branches of the superficial cervical plexus. Manipulation may relieve this discomfort and the patient may think that, as a result of

manipulation, there is less difficulty with the hearing, although no appreciable alteration has in fact taken place The apparent improvement will induce the patient to persevere hopefully with the treatment and the hopeful attitude of mind in itself tends to convince him of further amelioration

Moreover, in Nature there is always some tendency towards healing and repair This is itself a tremendous asset to all treatments which claim curative properties, since, whatever the system of cure employed, there will always be a percentage of cases which will naturally tend towards recovery, often not because of, but in spite of, the treatment Treatment, if sufficiently bad, will, of course, militate against recovery, but frequently a patient will tend towards recovery in spite of thoroughly unsuitable treatment In such cases the patient inevitably ascribes the improvement to the treatment, which in fact had nothing to do with it One good recent example is that of a patient with a short tendo Achillis who for four years had been unable to walk up or down stairs in comfort in spite of the fact that his main job in life was standing Alteration of his footgear at once enabled him to go up and down stairs with a freedom that he had not known for years He was grossly overweight His heart began to let him down and he was ordered complete rest from duty and a material reduction of weight At the end of two months his leg and foot symptoms had entirely disappeared, presumably as the result of manipulation, adjustment of foot-gear, rest and reduction of weight It so happened that he was ordered diathermy while in bed The *rationale* of this is not apparent Still nothing on earth will induce him to believe that anything but the diathermy has been the curative agency

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In trying to arrive at a scientific explanation of this fact, two points call for special consideration First, what do we mean by a joint lesion? and,

secondly, how far are we justified in believing that pain can be referred as a result of the lesion? To go a stage further, if pain can be referred as a symptom to a part more or less distant from the lesion, may it not be possible for other inimical stimuli to be similarly referred?

Here I left the discussion in the first edition and for this I have been criticised because it is obvious that I am leaving the answer to the osteopath, the cheiropractor and others who deal with joint manipulation. My silence in the previous edition was because I did not feel competent to answer these questions adequately and particularly the last of them, and I do not know how far I am justified even now in discussing the last of the problems. With regard to the first two, I feel more comfortable.

"Joint lesion" merely implies that there is some disordered function within a joint and therefore of necessity there is some abnormality, either in the anatomical relationship between the joint surfaces or some lack of normal physiological movement between them, or more often, both.

The answer to the second question I can only give as my own personal conviction—the result of extensive experience. Either of the two conditions mentioned can, and do, produce symptoms of which a patient may be conscious even though anything in the nature of actual pain may be lacking. As a rule, however, when a "lesion" is present there is an element of pain when the joint is subjected to the extreme limit of movement and particularly of movement which is not under voluntary control. At least we may go this far, that, on examination, both the examiner and the patient should be conscious that something is not well with the joint and that something is required to relieve the symptoms. This something is restoration of perfection of anatomical and physiological conditions. That referred pain from a joint that is not functioning normally may be severe and may radiate widely is an undoubted fact. Moreover, the radiation may prove to be deceptive. It is not common for anyone to be able to describe the exact distribution of symptoms and only once have I encountered a patient who has been able to describe his symptoms as referred from the fourth lumbar nerve root. Needless to say, he was a very well-known neurological physician. On examination it was movement of the joints connected with the second lumbar vertebra that reproduced the symptoms which the patient attributed to the fourth lumbar nerve root and it was due to restoring normal movement to the joints of the second lumbar vertebra that brought immediate relief from symptoms. Obviously the explanation must remain speculative, but the only rational explanation seems to be as follows: The nerve supply to any joint cartilage, synovial membrane or pad of fat within the joint, and probably even the nerve supply to the ligaments, is from the sympathetic nervous system. There seems to be no doubt that in the sympathetic nervous system there are certain fibres whose function is to convey the sensation of pain and that when these fibres reach the spinal cord their termination is a ramification upwards and downwards, extending to an area which would probably be covered by about four vertebræ. It is small wonder, therefore,

that, unless this fact is kept in mind and we disregard purely segmental distribution, diagnosis is apt to be fallacious

Now we come to the consideration of the third problem which really amounts to this if disturbance of joint function can cause referred pain, can disturbed function in a joint also convey other inimical impulses which cause disturbance in other organs? That this theory can be carried much too far, is, I am quite sure, a most undesirable certainty, but that abnormal impulses can cause some reflex effect, is equally certain Thus, for instance, it is not an uncommon experience for an abdomen to distend suddenly as a result of manipulation, and particularly of backward flexion, in the neighbourhood of the twelfth thoracic and first lumbar vertebræ That this is due to any conscious sensation on the part of the patient, can be disproved by the fact that a patient will often remain in a state of complete relaxation under an anæsthetic until this one movement is performed, when it is almost the general rule for the patient to begin heaving as if about to be sick Moreover, if the manipulation has not been completed, a very considerable increase in anæsthesia is required before the necessary relaxation is secured So far we are on firm ground, but to claim, because this is so that therefore all sorts and conditions of abnormal symptoms should be curable by manipulation, is, to my mind, a claim that approaches the ridiculous The eternal difficulty is to be able to decide between two problems First, to be able to say that the patient has improved, but it is quite another thing to say what has caused the improvement Take, for example, the claim of one well-known osteopath that he saved his wife's life by manipulation when she was apparently dying of pneumonia It is, of course, common knowledge that many patients apparently rapidly approaching dissolution with this complaint, and before modern treatment was known, suddenly recovered by crisis, and that at times something very near a miracle seemed to have happened in spite of the absence either of chemotherapy or manipulative treatment It was often "touch and go" and as often as not nursing skill was the decisive factor Adequate sleep might be classed as another decisive factor This depends on personal comfort—a comfort which some people only attain as the result of physical treatment, which may take the form either of massage, manipulation and even (in two extreme cases) of massage of the soles of the feet only All these things may be deciding factors in recovery, but I should hesitate very much to attribute that recovery to anything except producing a sense of confidence and comfort which enabled the patient to rest at the crucial moment

That the treatment of the spinal joints had any direct effect in altering the pathological condition within the lungs, would seem to be less probable than that the aid given to Nature to supply the adequate sense of comfort, which in turn allowed adequate rest and sleep, turned the scales in a favourable direction It is really a question of the same old story, it is quite one thing to say that "a patient got better" and another to say what was the decisive factor that turned the scale which led to recovery

I am not speaking now of the cure of conditions that have been wrongly

diagnosed. In Chapter III a list is given of a few of the mistaken diagnoses that will inevitably occur unless the movement of the joints has been investigated and, if necessary, corrected.

Now we come to another very great difficulty. There are many patients, take the deaf as an example, who in addition to the deafness, suffer pain and discomfort in the ascending branches of the superficial cervical plexus and if this pain and discomfort is relieved by manipulation of the joints in the neighbourhood of the third and fourth cervical regions, the patient will often suffer from the delusion that hearing has improved. This, of course, is a definite gain for the individual, in spite of the fact that no alteration in any of the structures connected with the auditory mechanism has been effected. Still, if manipulative treatment can convey a treatment by suggestion which adds to the well-being of the patient, it is surely justifiable, provided no false claim is made as an excuse for continuing treatment that is no longer required for physical reasons or likely to be of further assistance.

Finally, we come to the consideration of some of those conditions which in the present state of our knowledge are incurable—such, for instance, as disseminated sclerosis and Parkinson's disease. The variations in the former are well known, exacerbations are common, the downward wave is always followed by an upward one, but the down wave always exceeds the upward one that follows it. If, therefore, the patient seeks help when a downward wave is well advanced, it is a certainty that the upward wave will follow; and, if the patient is receiving manipulative treatment, the idea created in the patient's mind by the manipulation will be that treatment and improvement are cause and effect. That the upward wave would have come in the ordinary course of events without it, is, of course, a certainty. Now, let us consider these two diseases together. They both affect the muscular system and therefore, if the joints are perfectly normal, the muscles will inevitably have greater difficulty in functioning than if no disease existed. If, however, the joints are allowed to lose their mobility from any cause, the abnormal muscles will, of course, have all the greater difficulty in controlling the movements of these joints. The result is that only too often a disability will exist far in advance of that which is an essential part of the disease. From a manipulative point of view, we are powerless to alter the course of these diseases and therefore, inevitably, we are playing a losing game in the end; but, if by maintaining normal mobility within the joints we are able to assist the disordered muscular system to do the best of which it is still capable, the benefit conveyed to the patient may make all the difference to his being able to continue a useful career over many years, which without adequate attention to the joints would be impossible. In other words, to withhold joint manipulation because a patient is suffering from an incurable complaint, is merely a question of adding a functional disability to the physical one. Surely, therefore, we are more than justified in making life as easy and simple as possible for the muscles, instead of leaving them unaided to fight against an overwhelming disability which need not exist, and which might well amount to a serious disability even were the muscles unaffected.

And so the story might be continued indefinitely and my own belief at the present time can be summed up somewhat as follows —

An enormous amount of human disability and suffering is amenable to treatment by manipulation, even to the extent of cure

There are other conditions in which manipulative treatment can be of service in reducing disability to the minimum, when without it the patient would suffer unnecessary disability or discomfort

There is no doubt that the final downward fall into complete incapacity can often be postponed in cases of incurable disease

I can, however, only say that my experience, so far, has failed to convince me that any ordinary pathological process within the body is altered materially for the better or the worse with three exceptions first, there are many complaints which owe their origin entirely to disturbance of joint function and recovery is impossible unless the joint function is restored to normal by manipulation Second, that the symptoms which can arise as a result of joint derangement will often simulate organic disease and that these cases remain incurable unless the joints are examined and the necessary adjustment made Third, that if pathological changes within the body are present, a great deal may be done for the benefit of the patient by joint manipulation, even though it has no direct effect upon the main pathological condition present

On the other hand, I believe that the faith of those who rely entirely on manipulative treatment as the one superlative remedy, is unjustifiable There are many other treatments available which may prove more effective and there are so many pathological conditions that are better treated by other means at our disposal, including the whole gamut of physical treatment, that to rely on the one remedy alone is a great mistake Treatment of joints by manipulation, however valuable it may be in suitable cases, is only one of many physical remedial agencies that may be of service There are over sixty remedies—many with sub-divisions—available to the practitioner of physical medicine alone to extol one unduly is as unjustifiable as to disparage it, and countless other remedies are also available to the medical practitioner So it comes about that to prescribe treatment is all too easy to enlist the one remedy that will be of service is quite another story

CHAPTER II

THE JOINT LESION

THE ordinary surgical outlook deals with injuries and diseases of joints under the headings of strains, sprains, traumatic arthritis, subluxation and dislocation, and then proceeds to consider those various conditions which, disregarding accurate classification for the moment, we may group together as non-traumatic arthritis. Our immediate concern is with the traumatic lesions and especially to consider what is meant by the word "subluxation" as distinct from dislocation or luxation. Incidentally, it may be mentioned that the word "trauma" deserves, but has never received, proper definition.

Where a joint is completely dislocated there is generally no great difficulty in diagnosis. The joint surfaces are separated from one another to an extent that allows no doubt as to the condition present, though X-ray examination may be needed to establish the precise nature of the injury, and particularly to ascertain whether fracture has taken place at the same time. If function is to be restored, the joint surfaces must be restored to their proper relationship. In certain cases open operation may be necessary to render reduction possible, but usually manipulation alone will suffice. Manipulation of this type is quite distinct from joint manipulation as the term is generally understood : it is a surgical procedure.

It has always been recognised by medical practitioners that a condition of partial dislocation known as subluxation, and distinct from luxation or complete dislocation, can and does occur. In this condition the apposition of the joint surfaces is not altogether lost, but they maintain a fixed relationship to one another which is abnormal and does not permit of movement through the normal physiological range, owing to pathological displacement altering the anatomical relationship of the joint surfaces. In this condition, as in dislocation, manipulation is required to restore the normal anatomical relationship and the normal physiological degree of movement.

So far we are on undisputed ground ; but the osteopathic definition of a subluxation as "the immobilisation of a joint in a position of normal movement" carries us a stage further. This definition would seem to imply the possibility of a locking of joint surfaces without any actual displacement. Also, it might imply the existence of some factor which prevents the ordinary physiological movement of the joint surface of one bone upon the corresponding surface of another, despite the fact that the two joint surfaces maintain to one another an accurate gross anatomical relationship. We have therefore to consider whether this condition is a possibility, and if it can develop and persist in the absence of trauma, as that word is generally understood.

Take, for example, joints at the bases of the metatarsals (See Figs 211-216, p 157.) There are four at the base of the third. Three of these are insignificant in size and yet the least trace of disharmony between the working of the four of them will inevitably lead to discomfort, perhaps to pain and certainly to some degree of disability. It is surely easy to understand that perfection of harmonious working, when the full body weight rests upon the foot throughout a wide degree of movement might easily be upset. Recently a patient was admitted to hospital for a sympathectomy. Loosening the joints and a slight elevation of the heels rendered operation unnecessary. This is another example of mistaken diagnosis. The patient had been put down as suffering from intermittent claudication due to peripheral vascular disease. Yet there can be no doubt that the true nature of the symptoms was chronic foot strain which had led to disordered function of the joints between the bases of the metatarsals, though there was also a certain amount of loss of mobility in the ankle and sub-astragaloid joints as well. He was overweight and a waiter in a hotel, but he expressed his confidence that he could return to his work.

A study of the details of the movements of one bone upon another is an essential part of the consideration of the two problems before us. The fact that our knowledge of these movements was very imperfect was brought home to me many years ago, when for the first time I saw the use of the fluorescent screen as a means of assisting X-ray diagnosis. The vision so revealed was fascinating, although it was some time before its value could be properly assessed. I placed my hand in front of the screen so as to obtain an antero-posterior view. I then turned to secure a lateral view, putting my hand through the movements of dorsal and palmar flexion. The result was entirely unexpected, showing that the movement of dorsal and palmar flexion of the hand is an accurate description of the movement that takes place, while to speak of dorsi-flexion and palmar flexion of the wrist is anatomically and physiologically inaccurate.

The importance of this study was emphasised by a consideration of the different shapes of the facets between the articular processes of the vertebræ. Plainly the arrangement and the setting of these facets could not be a matter of chance, but must indicate that the arcs of movement in one typical area of the spinal column are different from that of another section. The reflection that every articular surface was so devised as to allow movement upon it of another articular surface gave added importance to the study of every articular facet however apparently insignificant. The fact that every part of every facet is there for use is borne home by the fact that when two bones which do not usually articulate with one another are accidentally brought into unduly close contact, a false joint is formed. Witness, for example, the false joint sometimes seen in such an unexpected position as between the spinous processes of two lumbar vertebræ. The formation of false joints is, of course, no proof that a joint surface would cease to exist if it were not used, but the study of X-ray photographs of abnormal joints such as those seen in cases of congenital dislocation of the hip, shows clearly that joint surfaces alter

Fig 1

Fig 2

Fig 3

Figs 1, 2 and 3 The photograph in Fig 1 shows the relative position of the bones of the carpus when the hand is in the mid-position between dorsi-flexion and palmar flexion The figure on the right shows their relative position in dorsi-flexion, and that underneath in palmar flexion of the hand Note that in the picture on the right the distal row of carpal bones has performed a wide excursion on the proximal, but that there is comparatively slight change in the relative positions of the bones of the proximal row upon the radius In the underneath figure the reverse will be noticed the excursion of the carpal bones on the radius is now relatively large, and comparatively little movement has taken place at the mid-carpal joint

very materially if they are not used in accordance with the ordinary laws of physiological movement It may be assumed, then that every articular facet is intended for physiological use throughout the whole range of the corresponding cartilaginous facet

To return to the carpal region, the importance of the study of the articular facet at the proximal end of the os magnum is at once obvious If the facet is there for use at all, it must be in order to allow a wide excursion of the semilunar round the end of the bone, but movement takes place mainly in the direction of dorsi-flexion and very little in the direction of palmar flexion

At this point it becomes obvious that as the semilunar glides round the head of the os magnum, the two adjacent bones, the scaphoid and the cuneiform, must glide with it otherwise an undue strain would be placed upon the ligaments which unite these three bones This leads on to a consideration of the shape of the joint between the two rows of carpal bones This is shown diagrammatically in Fig 4

At once it is apparent that there is more in the movement of joints than is dreamt of in the philosophy of the anatomical text-book It is one of the marvels of Nature that, irregular and unshapely as the joint surfaces may seem, the contour of each has been so shaped as to allow a certain degree of freedom of movement, but not such freedom as might permit either bone or joint to suffer unduly as a result of the external stress or strain of normal existence For instance, if we had but a single bone in place of each of the two rows of carpal bones, we should all, unless the shape of the articular facets between them were different from that now present between the two rows of small bones, have developed, as a result of repeated trauma, a chronic traumatic arthritis in these joints before we were ten years old!

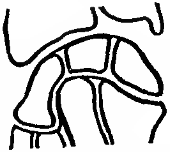

FIG 4 The sketch shows the shape of the facets which take part in the movements of the distal row of carpal bones upon the proximal row Note the extreme irregularity of the joint line

Not only are we provided with joint surfaces between the two rows of carpal bones, but every bone in each row has likewise joint surfaces between itself and adjacent bones This arrangement has a dual purpose The first is to allow a degree of freedom of movement of each individual bone in each row upon its neighbour, illustrated by the facets between them Thus the articular facet of each bone of the distal row can fit with the necessary accuracy and absence of strain on the corresponding facet of the proximal row throughout the full range of movement of one row upon the other

To understand the second purpose of the arrangement of the carpal joints we must consider the ligaments which unite the bones of each row to one another The arrangement of the ligaments differs, partly, no doubt, because of the difference in the shapes of the bones, but, beyond this, because the exact shape, strength and arrangement of the ligamentous fibres have of necessity been so designed as best to counteract any external strain

or stress which might cause injury in the absence of adequate protection. The arrangement of the fibres of the ligaments, no less than the shape of the articular surfaces, must have a definite bearing on the limitation of the movement of the joint surfaces on one another. The function of these ligamentous fibres can only be, as in all joints, to act as buffers to counteract the inimical forces of external strain and stress, and to put a check on movements when the physiological limit has been reached. In short, the purpose of the interosseous ligaments is to ensure stability. This does not apply to the capsular ligaments, whose function is to keep the synovial cavity intact.

No one, so far, seems to have offered any detailed explanation for the exact and almost unvarying shape of the articular facets, nor for the arrangements of the fibres of the interosseous ligaments with regard to the effect of both on physiological movement. Explanation is also lacking as to how the latter serve their function throughout the various changes which take place in, for example, the normal movement of dorsi-flexion and palmar flexion of the hand. For the time being we must merely accept their presence as serving the functions already attributed to them. What follows is applicable to most joints, and not only to the carpal joints.

Considering the strain and stress to which the region of the wrist is subjected even in the ordinary avocations of life, putting aside the more strenuous occupations, it is obvious that the arrangement of the joint surfaces and of all the ligaments which hold them in position is of vital importance to the normal functioning of the joints. Yet some at least of the interosseous ligaments seem to be rather poor things on which to rely for the maintenance of stability in the face of abnormal strain and stress. It becomes necessary, then, to consider what may happen if an external force acting on two adjacent bones, while insufficient to cause rupture of the ligamentous fibres, is too great to be counteracted by the ligaments without undue stretching.

It is plain that, if an abnormal rotation strain is put upon one of the bones of the carpus, the interosseous ligaments will also be put on strain, and so will tend to draw the adjacent bone or bones towards the one that has rotated. As the strain increases the articular surfaces between the bones must be drawn tightly together at the limit of the physiological movement. If the stretching of the ligaments allows this limit to be exceeded it is inevitable that the two articular surfaces should bind upon one another. Perhaps the engineering expression "seize-up," or, perhaps more accurately, "binding" will explain what is meant. The result must be discomfort usually amounting to pain and disorganisation of function within the joint concerned. True, the degree of disorganisation may well be very slight where the movement of the hand on the fore-arm is concerned. For instance, in the lateral movement of the hand upon the fore-arm relatively little movement takes place in the transverse carpal joint. (See Figs. 73 and 74, p. 83). Therefore we may safely assume that less still takes place in the joints between the individual carpal bones. Moreover, if the joint between, let us say, the scaphoid and the semilunar is not functioning properly, this would probably not interfere with the freedom of palmar flexion (which we have seen takes

place mainly at the radio-menisco-carpal joint), right up to the extreme limit of movement In dorsi-flexion too, in which the distal row carpal bones move freely on the proximal, the probable position for the locking of the scaphoid and the semilunar is one which would allow freedom of movement, at least until the physiological limit is approached This lesion might therefore easily pass practically unnoticed, since the transitory twinge of pain at the moment of accident is easily forgotten and, indeed, may hardly be felt in the excitement of a game or the shock of a fall, and thereafter there would only be trivial pain, perhaps not more than discomfort, when the physiological limit of movement is approached in dorsi-flexion The symptoms might therefore easily be described by the patient as a feeling of weakness rather than of pain yet some disability there must be, perhaps negligible, often annoying, usually handicapping even to the extent of passing on to the disabling level

Moreover, a binding of the type described may be caused by a displacement so small as to be indistinguishable on X-ray examination We must remember that the plane of the joint surfaces between the two bones which we are now considering is almost antero-posterior, but not quite There is a slight obliquity from behind forwards and inwards towards the mid-line of the carpus An ordinary antero-posterior view, therefore, cannot show accurately the spacing between the two bones throughout their antero-posterior depth Also, the shadow thrown by the semilunar would show so little alteration if it were rotated slightly on the scaphoid, that the difference between the normal and the pathological would be quite indistinguishable, as the movement of the one bone on the other is so slight In a lateral view the outlines are so obscured by the presence of other bones that the minute alteration can only be suspected rather than detected Even stereoscopic examination does not help us greatly, though it may increase suspicion to a moral certainty The reason is that the alteration of the shadows thrown by the two bones when in normal relationship and when locked is so slight that it is insignificant in comparison with the alteration shown by a slight modification in the angle of incidence of the rays used for the examination

We have to depend, therefore, on clinical proof of the existence of a lesion of the kind described We have shown that such a lesion is anatomically possible, and, if theoretical explanation of the symptoms is supported by clinical evidence, we have strong grounds for supposing that it does in fact exist

The first step in examination is always the same, namely to test the movements which are not under voluntary control, and, if possible, compare them with the movements of the joints on the other side Even though the range may appear to be almost identical, if there is any difference of which the patient is conscious, such as discomfort or even pain, then we know for certain that there is disordered function within the joints Even though the movements which are under voluntary control may appear to be within the limit of the normal, this is no proof that a joint lesion does not exist, and unless both the movements that are under voluntary control and those that are not, are symptomless, some abnormality must be present It is but seldom that

the movements which are not under voluntary control appear to be perfect while those that are under voluntary control are imperfect.

It seems certain that a large percentage of those who receive immediate relief as a result of manipulation of the "bone-setting" or "osteopathic" type owe relief to the amelioration of some such condition as has just been described. Countless patients will testify that something had "gone wrong" in the wrist region as a result of some false stroke at golf or tennis and that this "something" had interfered seriously with their game, while, as an immediate result of manipulation of the joint concerned, the symptoms entirely disappeared. As a general rule the patient is conscious of some unusual movement within the joint in the region under treatment at the moment the manipulative force is applied. Cases such as this are a daily experience with those who practise manipulative treatment. It is plain that a derangement of physiological function caused by the application of external force has been corrected by the application of another force, and it is a reasonable conclusion that the derangement was due to some binding or loss of normal mobility of the type we have been considering.

It is sometimes argued that the relief experienced in these cases is a result of the breaking down of adhesions. Against this there are several points that can be urged. First of all is this, that the disability is of instantaneous origin, and there is no subsequent swelling as in active traumatic arthritis. The nature of the symptoms, while they persist, is constant, and when they are relieved by manipulation there is no consequent reaction. Moreover, during the process of manipulation there is no such pain as is invariably associated with the breaking down of adhesions, and neither the patient nor the person performing the manipulation is conscious of any tearing sensation ; rather there is a consciousness of something slipping, frequently accompanied by an audible report, which is entirely unlike the sound caused by the tearing of a pathological band. Of course it is always possible that with a locked joint adhesions may also be present, and these must be overcome before the locking can be relieved. In this case some reaction, however transitory, is bound to follow the breaking of the adhesions. The breaking of a pathological band of necessity involves the infliction of a fresh injury—a fact only too often overlooked—and subsequent care and treatment is usually needed to ensure maintenance of mobility. This is rarely required when a mere locking or binding of two joint surfaces has been released. There is one exception : if the lesion has been present for a long time, the ligaments may have stretched enough to allow recurrence. A check-up on the maintenance of mobility is therefore always desirable : if adhesions have been torn, it is essential.

Adhesions never form instantaneously, and when they form the history differs from that given when they are absent. The first symptoms of injury are gradually altered as adhesions form, usually in the direction of increasing limitation of function with an increase of pain as the limit of movement is approached. The picture of the symptoms presented by the patient is rarely, if ever, a stationary one. Similarly the effect of the manipulation is progressive instead of being almost instantaneous as when a simple locking has been

freed The breaking of an adhesion almost always leads on to reaction, however trivial

So far we have been considering the conditions that occur when two articular surfaces lock or bind on one another in such a way as to cause a change from their normal relative positions, which, while not amounting to gross displacement, is still sufficient to interfere with the proper functioning of the joints We have now to discuss how a joint may suffer derangement of function in spite of the fact that the joint surfaces maintain a perfectly normal anatomical relationship Consideration of the ordinary movement of a metacarpo-phalangeal joint will demonstrate the value of a minute study of the physiological movements of the joints generally We shall see later that in full extension of a metacarpo-phalangeal joint the lateral ligaments are taut and that, with the beginning of flexion, the traction is relaxed, the slack being taken up as movement increases until finally they are taut again

FIG 5 Drawing of the head of a metacarpal showing that the articular surface of the head of the bone is not the arc of a perfect circle taking the origin of the lateral ligaments as a centre (Lateral view)

When we consider through its full range the movement which takes place at a metacarpo-phalangeal joint, we see that the phalangeal insertions of the lateral ligaments describe a circle round their metacarpal origin as centre, the line between origin and insertion being the radius Thus the movement as the base of the phalanx glides round the head of the metacarpal is not a true hinge movement The articular surface of the phalanx retains at every stage of the movement a constant relationship to the portion of the articular surface of the metacarpal with which it is in contact, and yet we note that, in full extension, the lateral ligaments are taut, but become relatively slack when flexion begins The arc of the phalangeal articular surface is an arc of a relatively wide circle, the arc presented by the outline of the articular surface of the head of the metacarpal is not This is diagrammatically represented in Fig 5 These anatomical facts have a marked bearing on physiological movement (*Cf* also Fig 9, p 51)

It is a matter of common knowledge that elasticity changes as life goes on Loss of elasticity does not necessarily imply pathological degeneration There is a family of acrobats in Lambeth who from generation to generation for well over a hundred and fifty years have trained as acrobats This family has found that, if for any reason a child is unable to begin training by the age of two, its chance of becoming a first class acrobat is negligible By the age of three the joints have become too stiff for the necessary mobility ever to be restored ! There is anyhow, no doubt that the mobility and elasticity of the ligaments in a newborn baby are very much greater than in an infant a year old, and that elasticity has again decreased quite disproportionately a year later when the child has begun to toddle By the age of six, even with perfect health the loss of infantile elasticity is very marked indeed It is, of

course, a fact that bone formation plays a large part in this decrease in mobility, but even after growth has ceased the loss of elasticity in a perfectly healthy body is progressive. It is true that loss of elasticity can be held in check, and even to a certain extent repaired (though it can seldom be fully restored if once it is lost), by the continual maintenance of complete function, involving the frequent movement of the joints concerned through their full range of physiological movement. If full movement is not performed elasticity is rapidly impaired, the more rapidly as age advances. The presence of pathological processes, particularly local sepsis, will increase the rate of deterioration.

Let us now consider what must happen if a metacarpo-phalangeal joint is allowed to remain slightly flexed, while for any reason the elasticity of the lateral ligaments degenerates. It must be remembered that the normal shape of the articular surface of the metacarpal head clearly indicates that full extension involves a degree of movement usually, but wrongly, described as hyper-extension, and that the straight position is really one of slight flexion. In this position the two joint surfaces are, as always unless traction is applied, in contact with one another. If the lateral ligaments lose any of their elasticity the full normal range both of extension and of flexion will be lost, since there will be a tendency for the articular surface of the phalanx to be pulled down towards the head of the metacarpal. Then, if movement occurs in either direction the base of the phalanx will in time arrive at a point where normally the ligaments are relatively taut. Elasticity having been partially lost, the pull on the articular surface of the phalanx towards the head of the metacarpal will at this point become so strong that further movement is impossible. Loss of the power of so-called hyper-extension interferes so little with the normal function of the fingers that it may well be overlooked. The loss of flexion, on the other hand, leads to a loss of function which is only too well known, and which is notoriously difficult to restore. The reason why restoration is difficult, however, is not so well understood, and this lack of understanding has rendered the treatment of the condition very often faulty. (*Cf.* Figs. 56 and 57, p. 72.)

When we consider the matter we must realise that, in the routine actions of daily life, it is comparatively seldom that we move any individual joint to the extreme limit of its range. This applies to some joints more than others. Countless people in the ordinary course very rarely pass their joints through the full degree of possible movement. Where the metacarpo-phalangeal joints are concerned inevitably some degree of the elasticity of the lateral ligaments is lost, and with it the capacity for a full range of movement. The same applies to many of the joints in the spinal region.

It is a law of Nature that just as the practice of function begets perfection of function, so neglect of function begets an ever-increasing loss of function. Thus prolonged lack of movement, even without any pathological process, is bound to hasten the loss of elasticity, and, as we have seen, the loss of elasticity alone is a common cause of loss of perfection of movement of one joint surface upon another.

Naturally the loss of elasticity, except as the result of injury or sepsis, is a slow process, and can be kept so, as far as any particular joint is concerned, by a very occasional movement of the joint up to the anatomical limit, but when this limit of movement is never performed the elasticity of the ligaments which control the movement is bound to degenerate steadily, until there comes a time when the consequent impairment of function cannot be ignored. Owing to the gradual progress of degeneration a very marked diminution in range of movement has often taken place before the patient suddenly becomes conscious of the limitation, for the limitation is unaccompanied by pain unless adhesions are present or some unusual external force is brought to bear. The word "adhesion" in this connection needs modification, as loss of the normal elasticity in any fascial plane will limit, and finally render painful any attempt to enforce full mobility.

Turning from what may be called normal loss of elasticity in ligaments as a result of neglect or disuse of complete function we have next to consider the result of trauma. The primary instinct of self-preservation is not confined to the preservation of life, but extends also to protection from pain and discomfort. Thus it comes about that where trauma has occurred and left a pathological condition which renders the full range of movement painful, a protective reflex contraction of the muscles opposing the movement is set up limiting the voluntary range to correspond with the painless one. When the result of trauma is acute the reflex contraction will serve to inhibit all voluntary movement. We must remember, too, that no single muscle or muscle group is represented on the cortex of the brain. The command goes forth from the cortex that a movement has to be performed, the impulse thus started spreads not to one individual muscle, but to many. If some one muscle thus stimulated fails to play its part, the movements will, as far as possible, be performed by others.

If, for example, a patient with a weakened deltoid is asked to raise the arm from the side in the upright position, the deltoid, if it has strength sufficient to do so, will play its part and raise the arm from the side, while the scapular muscles fix the scapula itself so that the humeral head may be free to move upon a stabilised glenoid. If, however, the load is too great for the strength of the deltoid, the imperious command from the cortex must be obeyed, and the arm will be raised in the only way possible—namely, by rotating the scapula. In order to perform the act of elevation of the limb as efficiently as possible, the muscles which can do so will contract in order to fix the humerus to the glenoid, and amongst these will be the adductors of the shoulder joint. These being the antagonists of the deltoid, it follows that, as they contract, the deltoid itself will tend to relax—the exact opposite of what was intended by the original impulse from the cortex. It is thus that sometimes, when performing muscle training, we seem to encounter a condition which almost amounts to a confusional insanity of muscle action.

The same process may take place to a minor extent, when a joint is liable to cause pain on movement. For example, if a knee is painful on full extension, the quadriceps will often act quite freely until the limit of painless

movement is reached. At this point the muscle suddenly relaxes reflexly, and the patient will complain that the muscle is weak and liable to "let him down." The joint, therefore, never passes through the full range of movement.

There are, however, other structures besides ligaments in which loss of elasticity may lead to limitation of joint movement. Even an athlete or a dancer may have a relatively short tendo-Achillis, but as long as his elasticity remains perfect this presents no disadvantages. When, owing to the passage of time, or perhaps after prolonged illness, the elasticity becomes impaired, trouble may follow in several directions. The attitude now adopted will be that which is familiar when walking up-hill. In other words, the lumbar concavity is habitually lessened. This lays a very considerable strain on the joints of the lumbar spine, and particularly on the lumbo-sacral junction.

Another example of a structure from which, if elasticity is lost, severe symptoms may arise, is the ilio-tibial band. This takes origin from the crest of the ilium, passes down over the outer side of the great trochanter, and from thence down the middle of the outer side of the limb all the way to the region of the ankle. If the hip is flexed the shortest path for the band passes in front of the great trochanter. When the hip is extended it passes behind it. It follows, therefore, that in the passage of the hip from flexion to extension, the band tends to tighten more and more as the vertical position is reached, and the band is raised up, as it were, by the great trochanter as it pushes its way underneath the band. The latter may even "snap" over the bone. The same applies to movement in the reverse direction. This can only have one result—namely, that as the leg passes backwards from flexion to extension, the front of the ilium is dragged upon so as to exert a forward torsion strain on the sacro-iliac joint, and as the limb passes from extension into flexion, the strain is released. Further, as weight is no longer borne by the limb, the tensor fasciæ femoris muscle relaxes and there is little actual "see-saw" traction on the joint, but the intermittent pull can cause a very marked irritation and lead to intractable pain.

The evil, however, does not stop here, as, if the ilio-tibial band is relatively short, it stands to reason that, if the thigh is fixed, the free movement of the pelvis must be impeded ; and thus strain is laid not only on the sacro-iliac joint, but also on the joints of the lumbo-sacral junction, and even on those higher up. In advanced cases lack of adequate elasticity in this band may be the sole cause of recurrence of a severe sciatic scoliosis, and is a very common cause of low backache. (Moreover, is it not possible that the intermittent pressure over the trochanter presses the head of the femur unduly firmly against the acetabulum, thus leading to unfair wear and tear? Is this another possible cause of monarticular arthritis of hip? It seems as if it might well be so.)

There can be no doubt that most of the pain in a condition such as this is referred from the joints as a result of strain, and yet the joints themselves—bone, cartilage, ligaments—may all be perfectly normal and there may be no trace of pathological lesion in any of them, notwithstanding the interference with the normal physiological action of the joint. Still, when the

joint has been subjected to long-standing strain added perhaps to a faulty position, freedom of movement becomes impaired, and treatment by manipulation may be essential for the relief of symptoms referred directly to the joint and of others referred through a wide distribution from the joint

Take as another example the shoulder joint of a patient who, for some reason, has been compelled to carry the arm dependent at the side without movement In the absence of the normal alternate contraction and relaxation the deltoid has tired with the effort to support the weight of the arm so as to keep the head of the humerus in proper relationship with the glenoid The head of the bone then tends to drop downwards on the surface of the glenoid until it rests against the lower edge of the articular surface on which normally there should be no pressure Pain and irritation are thus set up, the pain, often severe, radiating freely throughout the limb Yet there may be no apparent interference with the range of movement or the normal functioning of the joint Nevertheless, instantaneous relief may follow manipulation which consists solely of pushing the head of the humerus upwards on the surface of the glenoid And so a similar tale may be told of most of the joints of the body

CHAPTER III

REFERRED PAIN

It may appear that much of what is written in this chapter is outside the scope indicated by the title of this book. Possibly at some future date a sequel may be written to cover the movement and manipulation of the joints of the trunk. It would, however, be a mistake to leave the question of referred pain incomplete pending the appearance of a volume only just begun; especially as there is widespread misrepresentation of the scope of manipulative treatment, and its true aim and object are obscured by a fog of misunderstanding. The following pages are written and included here in the hope that by their help some at least of this fog may be cleared.

We have to consider the case where joint function is impaired when no inflammatory condition is present. In the absence of inflammation in any of the structures which form the joint there will be a limited degree of normal and painless movement; but if any attempt is made to pass this limitation of movement, some living structure will be subjected to traction or pressure, with consequent irritation of the structure and of its nerve supply. The nerve supply of the joints and ligaments is derived from the sympathetic nervous system, and the nerve fibres follow a complicated course, ultimately, through ganglionic connections, reaching the grey rami, which develop segmentally. The nerve supply to any joint is derived from several segmental areas; peripheral irritation sends out impulses centripetally. These impulses will ultimately reach a point where they affect fibres which convey the sense of pain. Since the impulses are distributed over several segmental areas it follows that, in response to a severe stimulus, a widely radiating sense of pain may be set up. This is borne out by the experience of everyone who has sustained an even moderately severe injury to a joint of an extremity. According to the severity of the injury the patient may suffer anything from trivial discomfort to such acute pain that collapse is almost instantaneous and is followed by a severe degree of surgical shock.

Some medical practitioners would appear to be unwilling to accept the doctrine of referred pain arising from within a joint. To reject it involves the denial of many well-established facts. It is universally recognised that pain felt in the region of the knee may be the first symptom of arthritis in the hip joint, while in later stages the pain from the hip radiates freely down the leg. So, too, pain is known to radiate freely through the upper extremity if the shoulder joint is inflamed. Again, most practitioners will acknowledge that pain can be radiated through the upper extremity as a result of an inflammatory condition in the joints of the cervical spine. It is difficult.

therefore, to deny that there may be definite radiation of pain from any inflamed joint.

We have now to consider, taking the segments of the vertebral column in turn, what symptoms might be expected as pain is referred from each. Starting from the upper segment we notice first the pain which radiates up the back of the head in the form of occipital headache. This pain may be so severe as to simulate true migraine, and no doubt it is the relief which has been afforded by manipulation to pain of this type which has led to the idea that true migraine can itself be cured by manipulation. Attacks of pseudo-migraine can certainly be so cured, and in these cases, if the possibility of their arising as a result of abnormal function of the joints of the cervical spine is ignored, a diagnosis of true migraine is probable, leading to the erroneous conclusion that a true migraine has been cured by manipulation.

A notable example of a case of this type was that of a war pensioner who in civil life had been a french polisher. A bullet had entered his cheek near the angle of the mandible, shattering it, and re-appeared between the two scapulæ, its course between these two points being unknown. When I first saw him he had for a considerable time been drawing a 100 per cent disability pension. The symptoms were these. Several times during the day an excruciating stab of pain would pass upward over the back of his head and he would drop like a shot rabbit, any food which he had eaten recently being returned. He was treated with the old Swedish suspension apparatus, and, as a result of this treatment only, returned to his work as a french polisher within two months, perfectly well and free from symptoms. He had been invalided as a case of migraine, whereas, in fact, he suffered from pain referred from the cervical spine due to the effects of an injury to the joints for which the suspension apparatus proved to be a sufficient remedy. Traumatic pseudo-migraine is relatively very common, and is readily amenable to manipulation.

Lower down we come to a widespread area through which symptoms may radiate from the joints of the cervical spine. A common distribution is along the branches of the superficial cervical plexus, and for some unknown reason pain radiates more often along the ascending than along the descending branches. Symptoms that appear to be due to posterior auricular, auriculo-temporal and transverse facial neuralgia can often be relieved by manipulation of the joints of the cervical spine.

In one difficult case acute pain was referred along the ascending branches of the superficial plexus and was associated with severe pain over the lower part of the corresponding side of the chest. This caused difficulty in breathing. The patient's head was held rigidly in a position of backward flexion and he was quite unable to lower his chin and he could swallow only fluids—and with difficulty at that; but for this an error of diagnosis might very easily have been made. The connection between the pain in the chest and the pain in the neck was not obvious at first, but reflection led to the conclusion that the pain in the chest must be due to spasm of the diaphragm caused by irritation of the root of the phrenic. The symptoms arose during sleep. In this case

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REFERRED PAIN

It may appear that much of what is written in this chapter is outside the scope indicated by the title of this book. Possibly at some future date a sequel may be written to cover the movement and manipulation of the joints of the trunk. It would, however, be a mistake to leave the question of referred pain incomplete pending the appearance of a volume only just begun; especially as there is widespread misrepresentation of the scope of manipulative treatment, and its true aim and object are obscured by a fog of misunderstanding. The following pages are written and included here in the hope that by their help some at least of this fog may be cleared.

We have to consider the case where joint function is impaired when no inflammatory condition is present. In the absence of inflammation in any of the structures which form the joint there will be a limited degree of normal and painless movement; but if any attempt is made to pass this limitation of movement, some living structure will be subjected to traction or pressure, with consequent irritation of the structure and of its nerve supply. The nerve supply of the joints and ligaments is derived from the sympathetic nervous system, and the nerve fibres follow a complicated course, ultimately, through ganglionic connections, reaching the grey rami, which develop segmentally. The nerve supply to any joint is derived from several segmental areas; peripheral irritation sends out impulses centripetally. These impulses will ultimately reach a point where they affect fibres which convey the sense of pain. Since the impulses are distributed over several segmental areas it follows that, in response to a severe stimulus, a widely radiating sense of pain may be set up. This is borne out by the experience of everyone who has sustained an even moderately severe injury to a joint of an extremity. According to the severity of the injury the patient may suffer anything from trivial discomfort to such acute pain that collapse is almost instantaneous and is followed by a severe degree of surgical shock.

Some medical practitioners would appear to be unwilling to accept the doctrine of referred pain arising from within a joint. To reject it involves the denial of many well-established facts. It is universally recognised that pain felt in the region of the knee may be the first symptom of arthritis in the hip joint, while in later stages the pain from the hip radiates freely down the leg. So, too, pain is known to radiate freely through the upper extremity if the shoulder joint is inflamed. Again, most practitioners will acknowledge that pain can be radiated through the upper extremity as a result of an inflammatory condition in the joints of the cervical spine. It is difficult.

extrinsic muscles of respiration When mobility of the joint is restored by manipulation, the symptoms vanish and the patient can resume his place in the team in two or three days

As we pass downwards through the thoracic spine and consider the possibility of the distribution of referred pain from each joint, we are able to see how it has come about that joint manipulation has received credit for "cures" which are in fact scientifically impossible For instance, pain radiated along any one of the intercostal nerves from the third to the seventh may be felt in the chest wall underneath the breast If now tenderness is elicited in response to pressure over the breast, it is extremely probable that a diagnosis of mastitis will be made This is all the more likely if, as is quite common, some little irregularity in the breast substance can be felt by the fingers A patient with a cancer-phobia may at once jump to the conclusion that this is the beginning of the end, and if, as a result of manipulative treatment the pain is relieved, she will almost certainly claim that the treatment has cured mastitis, and often will further claim that it has saved her from cancer In truth, mastitis has never been present, but merely pain in the chest wall referred along the intercostal distribution owing to impaired mobility in the intervertebral or costo-vertebral joints As a result of manipulative treatment mobility has been restored, and pain and tenderness have disappeared The condition of the breast, of course, remains completely unaltered

So, too, on the left side of the chest pain referred along the third to the sixth thoracic distribution will inevitably pass round the chest wall till it reaches the precordial area Here the pain may be of such a character that the patient is convinced that it arises within the heart, not realising that it may very well arise in the chest wall over the heart He presents himself in a state of anxiety to his medical attendant The anxiety raises the rate of heart-beat, and perhaps there may be a little irregularity of beat The diagnosis of angina pectoris may be made, and the psychological reaction may seriously affect the heart function If manipulation then relieves the symptom of pain, the psychological lesion (caused by the diagnosis and backed by the symptoms) will be relieved, and the patient will, not unjustifiably, claim that the manipulation has cured him of angina In fact there has never been any angina to cure, the diagnosis was inaccurate, being based on inadequate examination only a pseudo-angina has been relieved A case of true angina can never be altered for the better by manipulation, though it may very easily be altered for the worse

If pain is referred from joints still lower down in the thoracic region the distribution will pass over various parts of the abdominal wall Let us suppose, for example, that the pain is felt near the costal margin towards the front over the right side It may be severe, and certain movements may cause exacerbations Tenderness is felt over the anterior perforating cutaneous branch of the intercostal nerve, and this is mistaken for tenderness underneath, instead of in, the abdominal wall The diagnosis of gall-stones, or at least of biliary colic, is made, operation is proposed, the patient seeks manipulation, and the pain vanishes in a few minutes after a single manipulation Nothing will

again no other treatment than the use of the Swedish suspension apparatus was found necessary, and by this alone complete relief was afforded in two days. In these two cases of the relief of symptoms by use of the suspension apparatus it is probable that other forms of joint manipulation would have been equally successful, and perhaps more rapidly.

I also remember particularly the case of an elderly lady, by nature of most scrupulous habits and very careful of her personal appearance, who for two years had suffered so severely from facial neuralgia that she never washed one side of her face and always kept it covered with a pad to shield it from draught. On examination it was found that movement of the upper cervical spine in the recumbent position reproduced the neuralgic pain in the face. Manipulation under an anæsthetic secured an instantaneous and permanent relief.

When pain is referred along the descending branches, its path of radiation from the joints is far more often along the supra-acromial than along the supra-sternal or supra-clavicular branches, but as we proceed lower we find that pain may be referred from the cervical and upper thoracic spine along any of the branches of the brachial plexus. In this connection there is one point deserving of particular attention. The lowest constituent element of the plexus is the grey ramus, which ascends from the uppermost part of the thoracic sympathetic. This was stated to contain nothing but vascular fibres, but clinically there seemed to be evidence that pain conducting fibres are present as well, and, more recently, some physiologists agree that the inference from the clinical standpoint is justified. As far as the symptom of pain is concerned the distribution of these fibres is, roughly speaking, over the area of the deltoid. Let us take as an example the not uncommon case of bowlers at cricket or pitchers at baseball who, as a result of some specially severe or prolonged effort in bowling or pitching, suddenly experience an excruciating pain in the neighbourhood of the shoulder, which completely prevents them from taking their place in any team unless or until the pain is relieved. There is only one remedy which can bring relief. The nerve supply of the painful area is derived partly from the third and fourth cervical nerve roots through the supra-acromial branches of the superficial cervical plexus, and partly from the fifth and sixth nerve roots through the circumflex. When the patient is placed in the recumbent position the full range of movement, both of shoulder joint and of acromio-clavicular joint, is free and painless, as are the movements of the cervical spine from the third to the sixth. If, however, the hand on the affected side is placed on the opposite shoulder so as to pull the seapula away from the angle of the ribs, it will be found that there is a sensitive area over the posterior primary division of the second thoracic nerve. If the injury is severe there may also be tenderness near the perforating branches in the axillary line and near the sternum. Plainly the pain is referred along the seeond intereostal nerve, and fibres from this root pass into the grey ramus which ascends to join the brachial plexus. The irritation which is the primary eause of the symptoms is to be found in the costo-vertebral joint of the corresponding segment. This joint has become locked owing to the breakdown, due probably to over-exertion, of the co-ordinated museular movement between the intrinsic and

other examples of referred pain For instance, pain may be referred to the region of the kidney and the diagnosis of *ren mobilis* may be made as the cause of the symptoms If the patient complains that the pain is severe, and if support fails to bring relief, surgical intervention may be considered, or, on the other hand, the patient may be condemned as a neurasthenic In such a case manipulation may bring relief of the symptoms, and a claim will then be made that *ren mobilis* has been cured, or even a renal calculus, should any hint, as a result of inadequate examination, have been thrown out that this might be a cause of the symptoms

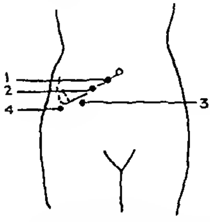

Fig 6 To show the close relationship between Baer's sacro-iliac point (1) and McBurney's appendicitis point (2) The former is given as two inches away from the umbilicus and the latter is situated roughly at the mid point between this and the anterior superior spine (This is not exactly the true description of McBurney's point but it is so near as to make no practical difference) Even in a corpulent subject the two spots are very close together while certainly not more than half an inch separates them in a thin subject (3) Indicates the point of sensitiveness which can be palpated on the iliac surface of the anterior superior spine if fibrositic deposits are present in the iliacus while (4) indicates the point at which the external cutaneous nerve may be caught as it passes through the opening in the deep fascia

Lower down errors in diagnosis may again give rise to stories of the miraculous "cures" of the manipulator Let us take the line drawn from the umbilicus to the right anterior superior spine of the ilium (See Fig 6) McBurney's appendicitis point is, roughly speaking, situated midway between these two points Along the same line, two inches from the umbilicus (i e , in a slim subject only about half an inch from McBurney's point), is Baer's sacro-iliac point It is not surprising, then, that many patients have had the appendix removed for the relief of pain in the right iliac fossa, and yet have failed to find the relief they sought Obviously pain in the ligaments on the anterior aspect of the sacro-iliac joint cannot be cured by removal of the appendix! On the other hand, the diagnosis of chronic appendicitis having once been made, operation is naturally advised The patient, anxious to escape operation visits a manipulator, whose treatment, as a result of "unlocking" a lock in the sacro-iliac joint, relieves the traction on the ligaments, and with it the pain and tenderness The patient will naturally conclude that the manipulator has cured a diseased appendix—a conclusion entirely unjustified, though the claim is perfectly justifiable that the manipulator has saved an unnecessary operation In fact, the disappearance of the symptoms as a result of manipulation is itself a proof that the appendix was in no way responsible for the symptoms At the same time until medical men generally realise the significance of tenderness over Baer's sacro-iliac point, the idea that appendicitis can be cured by manipulation will persist in the minds of patients and manipulators alike—and not without reason

Incidentally it is worthy of mention that further out on this same line—from umbilicus to anterior superior spine—palpating fingers may press on the surface of the iliacus muscle If this is infiltrated with sensitive deposits—fibro-myositis of the muscle—pain will result without either joint or appendix

prevent the patient from proclaiming that the "magical healer" has cured him of gall-stones, owing to the skill of his "miraculous hands." The possibility of a gross error having been made in diagnosis does not occur to the patient or to the medically unqualified manipulator, and so another impossible—nay, fantastic—"miracle cure" is noised abroad. The fact remains that no gall-stones were present—or, if they were, they had not been the cause of the symptoms—and there was not, and probably never had been, any disturbance within the gall-bladder. The symptoms were in the abdominal wall over the gall-bladder.

To show that this is not an imaginary case the following example may be quoted. One of the qualified staff of the Massage Department at St. Thomas's Hospital had had several attacks of severe pain, which had been diagnosed as biliary colic. She was admitted to a ward for operation, but X-ray examination showed perfectly normal functioning of the gall-bladder. Nothing abnormal could be found clinically in the quiescent period, and she was discharged. Almost at once the pain returned, and she asked me—not in the hope of receiving help, but merely as a friend—what could be done next. The attacks were frequent and incapacitating. This was in the early days, and I had not yet realised the extent to which referred pain could simulate symptomatically non-existent pathological conditions. With no idea of helping except by moral support, I examined the patient, who at once placed her hand over the gall-bladder area as the main site of pain. Palpation showed the muscles to be rigid, and there was acute tenderness. In answer to the question : "Is the pain always in the same place ?" the answer was : "Yes—and all round here"—pointing to the side of the chest wall. I then found that "all round here" extended segmentally round the chest wall and led ultimately to the region of the spinal column. Forcible extension of the spine at this point was found to cause pain to shoot round the chest wall directly to the sensitive area. Manipulation at once restored a lost mobility, the symptoms subsided altogether in the course of a few hours and the patient was "cured." It is her custom now, on the return of symptoms, to ring me up and ask me to "cure her gall-stones for her" ! It was this case that first led me to understand how faith in the incredible "cures" of the manipulator had gained so wide a hold.

Again, symptoms referred along the intercostal nerves from the joints may arise on either side in the abdominal wall and on the left side over the gastric region. A little use of the imagination will convince the patient that the symptoms are connected with food. The diagnosis of indigestion in some form, or even of gastric ulcer, may be made ; and, if the symptoms are relieved by manipulation, both patient and manipulator are led to the belief that indigestion and gastric ulcer can be cured by manipulative treatment ; and possibly even to the belief that it can cure or avert even cancer itself. The symptoms that arise from these complaints can, undeniably, be simulated to a certain extent by those arising from referred pain from the joints, and if this possibility is ignored errors in diagnosis are bound to occur.

The intercostal nerves supply the whole of the abdominal wall, but it is needless to carry the tale further. Something must be said, however, of a few

So, too diagnosis of occipital headache and similar "neuralgias," lumbago, brachial neuritis, sciatica, and the like, may be scientifically correct, but, if so, very definite indications are present. If these indications are absent it is probable that the symptoms are referred. As long as the possibility of referred pain from a joint is ignored errors of diagnosis will continue to be made, and victims will be driven to resort to the medically unqualified manipulator. In the event of his success both will proclaim his "miracle cures" and spread abroad the idea that help can only be found outside the medical profession, where, and where alone, the "magical touch" ought to be found.

This is no place to set forth the differential analysis of referred pain from the spinal joints. It has been done elsewhere.[1] The object of this book is to try to explain the technique of joint manipulation and the anatomical and physiological laws on which that technique is based.

The substance of all that has been said so far may be summarised as follows:—

(1) There is no magic in joint manipulation or in the effects produced by it. Primitive medicine and magic were interwoven in the hands of witch-doctors and others, and any return to the belief that magic as a curative agency still exists is a retrograde movement. Yet many patients still seek it as did Naaman the Syrian of old!

(2) If relief of symptoms follows manipulation, it is because some pathological condition has been remedied. It is incredible that relief can come otherwise than in accordance with the laws of anatomy, physiology, pathology and psychology.

(3) If the existing knowledge of these laws does not cover proved facts it must be extended. No one would claim that the ultimate limit has been attained in any one of these sciences. If, as has been abundantly established, joint manipulation is a potent agency for good over a wide range of cases, we must add to the accepted pathology of joints a conception of disordered function without gross displacement and without a condition covered by the word "arthritis" as that word is generally understood.

(4) The doctrine of referred pain must find wider acceptance, or else medical science will not be able to prevail against the atmosphere of magic and unreality which surrounds the cure of symptoms by manipulation. It is not a great thing to ask of the profession that, where symptoms do not fit in with routine diagnosis, or do not respond to treatment, the nerve supply to the part affected should be scrutinised, and the joints examined in the neighbourhood of the origin of, or near the path of, the nerves found to be involved.

(5) All prejudice against manipulative treatment must pass into the realm

being at fault. Again, on the same line just below the anterior superior spine of the ilium we come to a point where the external cutaneous nerve passes through an opening in the deep fascia just below the spine. This opening allows a minute degree of free movement of the nerve. If, as the result of hæmatoma or from some similar cause, the orifice is closed in upon the nerve, the nerve is liable to become adherent, and then the constant movement of the thigh may lead to an intractable traumatic neuritis.

Even now the whole tale has not been told of symptoms arising in the iliac fossa. If pain is felt on the left side the diagnosis of appendicitis is improbable, but, if the patient is a woman, the symptoms are likely to be attributed to trouble in the generative organs, particularly if there is any trace of prolapse or any—even trifling—disturbance of normal function. The pain may be relieved by manipulation, and the patient in that case naturally believes that manipulation has cured the trouble previously diagnosed. The symptom of pain may certainly have been cured by manipulation, but, if so, the pain was referred from one or more spinal joints, and the condition given as diagnosis either was non-existent, or, if present, was not responsible for one of the symptoms which troubled the patient, namely, pain.

Finally, something must be said of the terribly tragic frequency with which the diagnosis of neuritis, rheumatism, lumbago, or sciatica is made. After all, what do these words mean ? Are they a diagnosis at all, or are they from a scientific point of view well-nigh meaningless ? For the most part these terms are used to indicate nothing more than that the patient has pain in one portion or another of the anatomy—a fact of which he is already aware ; and the diagnosis amounts only to an acceptance of the source of the symptom as physical and not psychological ; treatment is confined to that of the symptom, the cause only too often is ignored. There, as far as the diagnostician is concerned, the matter ends. This is the opportunity of the free-lance practitioner. The patient who, it may be, has suffered many things from many physicians, and even from surgeons, and is none the better, flies to the irregular healer, and possibly gains relief. Rest, liniments, strapping and so forth are often utterly inadequate remedies for local symptoms in and around joints, and still more for the treatment of symptoms referred from joints ; and, if manipulation of the joint is an essential part of cure, even massage and electrical treatment are bound to fail. Nothing but function can restore function, nothing but movement can restore movement.

Again, it is contrary to all reason that a diagnosis of "rheumatism" should be made when severe pain starts locally and instantaneously as the result of special strain or effort. Yet we hear of "intercostal rheumatism" coming on suddenly in a football scrum. The correct diagnosis is a locking of a costo-vertebral joint. Similarly, when a man is struck down with paralysing pain while swinging the engine of a reluctant car he is often said to be suffering from "traumatic lumbago." This is not really a diagnosis but only a description of symptoms with reference to their onset, and it serves as a cloak for ignorance of the exact cause of the onset, which is usually a binding of the sacro-iliac joint.

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(5) All prejudice against manipulative treatment must pass into the realm of history now that the treatment can be placed on an entirely scientific basis

(6) There is no justification for looking askance at manipulative treatment because fantastic claims have been, and are still, made for it These claims are certainly built on a basis of error The error, however, as has been shown, is often in the diagnosis rather than in the treatment

[1] Backache by the same author J & A Churchill Ltd 2nd edition Now out of print awaiting publication of Part II of the present volume

(7) If errors in diagnosis on the part of the medical profession are to be reduced, the technique of the examination of joints should be disseminated throughout the profession without any avoidable delay. This involves closer intimacy with the work now being done in the branch of medical science known as Physical Medicine.

(8) It is very desirable that what is perhaps the most common reproach levelled against the medical profession as a whole should be countered once more by a simple statement of the facts. The accusation is freely made that medical men and women, out of sheer mulish obstinacy, have, without reason, set their faces against manipulative treatment. They certainly have in the past set their faces against it, but it is not true to say that they had no valid reason for doing so. The treatment was shrouded in mystery and was mainly administered on the basis of a pathology in which most qualified medical practitioners could place no credence. They could not possibly prescribe the treatment when to do so would have amounted to prescribing an unknown remedy for an unknown condition, and when the treatment would of necessity have to be entrusted to one whose pathological creed they could not accept. Such a procedure could only lead in some cases to injury and disaster. It was better that some should be debarred from playing football, golf or tennis, than that any should risk irreparable injury not only to the joint involved, but possibly extending to the loss of a limb or even of life. That cures by unqualified manipulators were—and are—numerous is undeniable, and these are universally noised abroad; but there were—and are—also tragic failures, and of these little is ever heard. As long as danger of causing these tragedies was present no conscientious medical man could possibly prescribe the treatment. Now, however, that the treatment has been placed on a truly scientific basis there is no reason why the medical profession should continue to view it with disfavour. In the past, while there has been no ground for reproach in the fact that the profession declined to recognise a treatment in which it could have no faith from a pathological point of view, it may fairly be deemed a reproach that so long a time has been allowed to elapse between the first general recognition by the public of the benefits of the treatment and the building up of an adequate scientific foundation on which the treatment could be based. It is profoundly to be hoped that this reproof will be removed from the medical practitioners of the future.

CHAPTER IV

GENERAL RULES OF JOINT MANIPULATION

The following pages are the result of experience gained during about forty years of constant practice of joint manipulation. If it is asked why they have not appeared before, the answer is that, though the technique has altered little, the exact *rationale* for each detail has been very difficult to work out. Even now it is not complete. Allowance must also be made for the natural shrinking from the almost impossible task of describing on paper the details of a delicate technique. Cinematograph photography will solve the problem in the future, but it will need verbal explanation. It may be that these pages will supply the need, with the aid of the "talkie" film that the University of Southern California and the United States Army Medical Department have so generously enabled me to prepare.

A certain degree of risk is involved in all joint manipulations. There are cases in which it is obvious that manipulation is desirable, others in which obviously it is undesirable, but in many cases there must be some doubt as to whether it is wiser to move or to postpone movement—perhaps indefinitely. The late Mr W. H. Trethowan, the well-known orthopædic surgeon at Guy's Hospital, was, as the result of a very wide experience, a notable advocate of manipulation. His dictum, "when in doubt, move," has a great deal to be said for it; but, on the other hand, certain factors must be eliminated before we even admit any "doubt." It is essential to know what these factors are.

In the first place we must know whether the joint under suspicion is functioning normally throughout the full range of anatomical movement in accordance with the physiological laws that govern its movement. To be sure of this we must know exactly what movements are performed at the joint, the mechanism of these movements, and their normal limitations. The usual text-books are of little help to us here, as they only describe those movements of the various joints which are effected by the muscles controlling them. Nothing is said of those other movements which can be performed only in response to an external force and which are not under voluntary control. Moreover, when examining the movements of joints, it is essential to study the question of the posture of the part under examination. The importance of this study will be stressed in the following pages. The most striking instance of the influence of posture will be found in examining the movements of the joints of the spine. The curves alter with every change of posture, and with every alteration of curve the normal limits of physiological movement alter also. Thus rotation and sidebending of the cervical spine are far more limited in the upright position than when the patient is recumbent. This is a natural result of the flattening of the normal cervical curve as the patient lies down. The same occurs with some of the joints of the extremities. At elbow and knee, for

instance, there is normally no lateral mobility when the joint is in full extension. With the smallest degree of flexion lateral mobility is present in both, usually to a marked extent. The positions in which each movement can be examined to the greatest advantage will be considered *seriatim.*

When it has been ascertained, as a result either of demonstrable limitation of range or of evidence of abnormal reaction to movement, that a joint is not functioning freely through the whole range of normal movement, the question arises whether or not it is wise to apply a mobilising force. The alternative is, of course, to rest and support the joint.

It is common knowledge that, if certain conditions are present, forcible movement is unwise, and even dangerous. The danger of moving a tubercular joint, or even one that is septic, is universally recognised. It is true that in the case of a septic joint, provided that drainage is adequate and complete, and that the treatment is entrusted to a manipulator who has had wide experience in dealing with acute cases and who fully appreciates the danger of the condition, early passive (*i.e.*, painless) movement may rightly and properly be prescribed, but the movement in such a case is the antithesis of the type of movement now under consideration. When any force is applied to move a joint in which active inflammatory processes are present there is always a danger that irretrievable harm may be done.

It is vitally necessary, then, that, when faced with disordered function in a joint, we should know whether the cause is purely mechanical, *i.e.*, whether a simple locking or seizing up of two joint surfaces is the source of trouble, or whether there is bony, cartilaginous, or soft structure impediment. If this last is the cause of the disordered function, we have to decide whether the mischief is in the soft parts which are included in the structure of the joint itself, or in other structures anatomically distinct from it. In any event we have again to decidc whether the impediment is due to active inflammatory processes or to the result of a past inflammation whieh is now quiescent.

Fortunately, a eareful serutiny of the history, combined with the result of X-ray examination, will go a long way towards showing us how far, if at all, bony or eartilaginous change is responsible for impaired function in any particular joint. Where, however, X-ray examination reveals such changc we arc at once faeed with the question whether we are to eonsider that this of itself is an adequate bar to manipulative treatment. It is true that thc ehange provcs an inflammatory proeess to have becn present, but it by no means follows beeause inflammation has been aetive in the past either that activc inflammation must still be present or that forced movement will stir dormant inflammation into renewed activity. An impression of thc prcscncc of an active inflammation is sometimes definitely eonveyed by X-ray examination, but usually the evidenee for or against manipulative treatment must bc found in clinieal observation.

History of onsct is often of vital importance, and it must be remembcrcd that a minutc trauma, whcn a sealcd focus of infeetion is present (*e.g.*, at thc root of a tooth). oftcn leads on to ehanges out of all proportion to the original injury. Of the many thousands of travellers who strap-hang every day quite a

large proportion sustain some sudden strain on the shoulder joint owing to an unexpected jolt of the tram or 'bus, but only an infinitesimal proportion develop adhesions in the shoulder in consequence The reason for this is not far to seek, the strain of itself causes only a very mild and transitory inflammation as a rule the repair is rapid and the recuperative process complete within a few hours During these hours, however, vitality is lowered, and if in any case a sealed focus of infection is present in tooth, tonsil, sinus or elsewhere, the infection is apt to affect the strained joint In this event the inflammation may assume an unusually serious character, and is maintained by the movement of the joint until it becomes chronic and adhesions form

To return to the consideration of inflammatory processes in a joint, the process, if active, is in many cases evident from the well-known symptoms of heat swelling, tenderness and pain on movement, any or all of which may be present

In some cases of symptoms derived from a joint there may be noticed what may be called a joint facies If the abdominal facies is described as a look of anxiety, this may perhaps be described as a look of fear—one of apprehension lest movement should cause pain It is a reflex expression inspired by the instinct of self-preservation, which may change to one of anxiety if pain becomes continuous and severe The look of apprehension comes first when the danger point, as regards pain, approaches, and is seldom seen if active inflammation is not present In late stages of wide-spread arthritis the appearance may be somewhat parchment-like

Where inflammation is very slight or is subsiding, there may be great difficulty in deciding the vitally important question whether symptoms are due to active inflammation or to the effects of inflammation now quiescent Experience in examination is the best guide, but even the most experienced is liable to an error of judgment There are however, certain points which may help to the exercise of a proper discretion

When a patient complains of pain in a joint, we usually receive one of two different histories There is the story of stiffness on waking in the morning, and of moving the joint with caution while it gradually loosens out more or less painfully, until presently it appears to function relatively normally Thereafter continuation of movement, particularly in the weight-bearing joints may lead to a gradual increase of pain, which will ultimately compel rest On the other hand, pain and discomfort may be absent as long as movement is maintained In either case there will inevitably be a return of pain as soon as movement is resumed after a period of rest This is the typical story of mild active inflammation

In cases where the inflammatory process is quiescent and the symptoms are due solely to the effect of a past inflammation, we get a completely different story After rest the early movements of the joint are painless, but pain increases steadily and in direct proportion to the amount and extent of movement Rest brings relief and after rest the movements which had caused pain are for a time painless once more

Thus the differential characteristic of the two conditions is that, whereas an

actively inflamed joint is painful at the beginning of movement after rest, but may be relatively painless once it has been "got going," in the case where the inflammation is quiescent the earlier stages of movement after rest will be painless and pain will increase steadily as the range of movement is advanced.

Further, if inflammation is active, pain may sometimes be comparatively slight when movement is performed by the patient in one direction, but may be severe on the return journey. When the movement is performed for the patient, if no similar symptom is aroused, a mild degree of active inflammation is almost a certainty. Again, movements may be free up to a certain point, then for a space become very guarded, and then free again. The guarded movement brings to mind the course of a careful motorist negotiating a dangerous corner or bend. On the other hand, if the symptoms are due to the effects of a past inflammation, movement may be free up to a point, but once that point is reached the range of painless movement ceases once and for all. As the danger point is approached the rate of movement may slow down, but once that definite point is reached movement will come to a dead stop. Sometimes jarring a joint by carefully controlled blows with the side of the clenched fist will give valuable information. If inflammation is active, the jarring will in some directions almost certainly be painful, though not necessarily in all. If inflammation is quiescent, the jarring is painless.

Therefore, having taken all these matters into consideration (it is well once more to impress the vital necessity of securing as accurate a history as possible), we can reconsider the X-ray appearances. These may show the mischief to be so advanced that we know at once that to make any attempt at forced movement is useless. On the other hand, if the bone and cartilage changes are not such as to limit movement to the range that is present on clinical examination, it is always justifiable to see whether manipulation can improve matters. The fact that cartilage or bone change is visible only means that inflammatory processes have been at work—it does not necessarily follow that the pain and disability from which the patient suffers are due solely to this change. X-ray examination shows the effect of the inflammation on the bone and cartilage, but it tells us nothing, as a rule, of the effect of that same inflammation on the soft structures. Yet the pain and the lack of function of which the patient complains are often due to the changes in the soft parts rather than to those in the bone and cartilage. If changes in these are far advanced we cannot, of course, hope to secure perfection, but alleviation is often possible, and the patient probably hopes for nothing better. Therefore the fact that X-ray examination proves that inflammation has in the past been sufficiently severe to cause definite cartilaginous and bony change must not be taken to indicate that treatment by manipulation can do no good, or even, as is sometimes held, that it must of necessity be dangerous.

Having once decided that manipulation is justifiable, the first step to be taken is to ascertain the extent of the limitation of movement within the joint, and, as far as may be possible, the nature of the limitation.

Although no one is justified, when there is the faintest excuse for doubt.

in manipulating a joint without in the first place examining an X-ray photograph of the joint, yet a practice has slowly developed which must meet with the strongest condemnation This consists of a reversal of the correct order of examination, which is to take the history as fully as possible, to prepare the patient for examination so that not only the suspected joint may be accessible but the whole of the region involved, and perhaps even more distal regions Then full details of the examination should be recorded, and these should be compared one by one with the history Finally, but not till the very end, the X-ray photographs should be examined and the findings compared with the history and result of examination If incompatibilities are discovered, both history and examination must be revised if the X-ray evidence cannot then be reconciled with that of the other two stages of examination, the X-ray evidence is fallacious and re-examination becomes essential To examine the X-ray photographs before examining the patient is to court error in diagnosis, or, even if this is avoided, it must often tend to prejudice the success of subsequent investigation For example, in three recent cases—all sent in the expectation that joint manipulation would be of service—patients have presented themselves with the history and symptoms of fracture They were a marching fracture of the neck of a metatarsal, a spiral fracture of tibia and a fracture of os calcis All three came with X-ray photographs showing no evidence of injury to bone, and had been treated accordingly as sprains Yet the evidence of history and examination was so strong that it seemed obvious that the evidence of the X-ray examination must be at fault Re-examination proved this to be so, though the case of the fracture of os calcis required three examinations before the diagnosis was confirmed So the tale can be continued indefinitely To start an examination with pre-conceived ideas as to a diagnosis gleaned from X-ray photographs is to start handicapped, and differential diagnosis is sufficiently difficult without this Moreover, it tends to encourage slovenly methods in examination The only real value of X-ray examination is when it is used to confirm a diagnosis or to prove or disprove any suspicion that may arise The best that any X-ray photograph can tell us about a joint is that the shadows thrown indicate the probable absence or presence of gross bony change, of gross cartilaginous change or of alteration in the spacing between two joint surfaces If these things are noted, then their value is assessed according to the previous clinical findings, and they may even call for re-examination of certain points, though, to be perfectly honest, this should never be necessary, if the first examination has been as careful and complete as it should have been Used thus it is often surprising to find to how small an extent gross changes may interfere with function On the other hand it is at least equally remarkable how severe may be the interference caused by minute alteration of spacing between the joint surfaces To this all too little attention is usually paid, while far too much is often given to marked change The real bugbear of all manipulation work is atrophy of bone, and, if it were only to exclude this one thing, X-ray examination should always precede manipulative treatment No clinical acumen can prove it to be present it may be

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Therefore it is always better to err on the side of caution than to attempt too much, and, if gross limitation is present in a joint that has a wide range of movement (and this particularly applies to the shoulder and elbow joints), it is much wiser to move the joint through the first "dead point" and to stop rather than to proceed with the breaking-down of adhesions which limit the movement in other directions

If just one pathological band is broken down in this way the reaction is very slight, and the next day the patient will experience a freedom of movement that was lacking before the manipulation was performed Voluntary movement within this restored range will usually lead to an increase of range, as movement always tends to beget movement Indeed, it is surprising to find how steadily a patient will tend to improve, and how he will very often regain by natural processes a range of movement far in excess of that which was secured under the anæsthetic Before perfection is restored it is, of course, not uncommon for improvement to cease, then the adhesions which limit the movement in some other direction must also be broken down The time at which this ought to be done is often a matter of doubt, and it is well-nigh impossible to give a certain guide

This much may be said with safety, that it is rarely, if ever, wise to do a second manipulation within two weeks, and usually it is better to wait for twice this length of time A great deal must depend on the progress of the case In making this decision it is wise to follow strictly another rule of physical treatment—namely, not to interfere while progress towards recovery is continuing On the other hand, once it is certain that progress has ceased there can be no good reason for delaying further unless signs of reaction still remain

One very important consideration which seems to be overlooked by those who advocate the securing of the maximum range of movement at the first attempt is that, when limitation of movement has been present for a considerable time the elasticity in the soft structures must inevitably have degenerated to a certain extent If it is true that movement begets movement, it is equally true that movement maintains elasticity and that absence of movement causes some loss of elasticity Indeed movement will often restore an elasticity that has been lost One of the great dangers, therefore, of doing too much is that the elasticity of the fibrous tissue in the muscles which control the movement of the joint may have become inadequate to allow of the full range of movement being performed without subjecting these tissues to undue strain To move through the full range a joint that has been severely bound down by adhesions is very liable therefore, to inflict a severe muscular strain, recovery from which may be long and tedious The injury inflicted may prove so great an impediment to subsequent treatment that it will never be possible to attain the full range of movement which, without such strain would have resulted from the manipulation The maximum range is not of necessity the optimum range

If the ligaments have been shortened or contracted with pathological bands for any length of time, we may be fairly certain that elasticity in these

suspected, but equally it does appear in most unsuspicious circumstances. The two other things we want to know from X-ray examination in manipulative treatment are whether there is evidence of gross disease—mainly tuberculosis and malignant disease—or whether changes are such as to render it inadvisable to attempt to restore the full range of movement. By way of emphasis it may be well to repeat that a negative X-ray examination does not necessarily exclude severe joint injury, or even, as has been shown, severe bony injury. It may tell us little or nothing about the state of the soft parts, which after all are an integral part, and from the point of view of manipulative treatment usually the most important part, of every joint. It does not even exclude the presence of severe inflammatory processes in joint or bursal spaces or even in bone. The statement that there is no evidence of injury or disease must not be mistaken for the statement that no injury has been done or that no disease is present.

Another problem then presents itself. If the limitation of movement is obvious, and if the presence of adhesions within the joint is suspected, we have to decide to what extent it is wise to move the joint, and further, whether it is wiser to move it at once through the full range of anatomical movement or to proceed gradually. There is one school of thought which teaches that if a joint is fixed to any extent by adhesions, the only sensible thing to do is to put it through its full range of movement at one sitting. This is a view from which I personally strongly dissent. If the limitation is trivial, then, of course, the amount of injury done to the soft parts in restoring the full range of movement will also be trivial. If, however, gross impediment to movement is present, it stands to reason that there is a great deal of it to be overcome, and it may well be that, in overcoming so extensive opposition, an injury will be done to the soft structures which will cause the reaction to be severe. Often enough if too much has been attempted, it will be found on examination the next day that the range of free movement is not so wide as it was on the day before the manipulation took place. Now, it is a rule of physical treatment that, if the procedure of one day leads to diminution of movement on the next, too much has been attempted. Increase of pain, increase of swelling, or decrease in mobility should always be regarded in physical treatment as indicating that an overdose has been administered. The converse, of course, holds good that decrease in pain and increase in movement indicate that the treatment has been properly controlled.

If inflammatory swelling is present, it is always unwise to manipulate unless the swelling and the limitation of movement are both plainly the more or less immediate sequel of a definite trauma. If a joint is much bound down with adhesions, the result of tearing these down one after another at the same sitting invariably leads to some degree of effusion, pain and stiffness. It is, of course, true that if these are only present to a slight degree they will be transitory and the treatment will prove beneficial; but if, as is probable, the reaction is severe, the utmost difficulty may be experienced in maintaining movement; and, if movement cannot be maintained, the adhesions will inevitably re-form.

anything resembling it, during manipulation, is a gross error of manipulative technique

Again, nothing that could be described by the word "jerk" has any proper place in the application of the mobilising force, something far more deliberate and delicate is required The application of the final mobilising force must be sudden, but it must be under perfect control, so that its application may cease at the exact moment when the desired movement has been accomplished "Thus far shalt thou go, and no farther" must always be in mind as a guiding note It is not, therefore, enough to say "take up the slack and push or pull"—the push or the pull must be under perfect control, and always in a direction that will ensure the performance of normal physiological movement Would the words "thrust" and "tug" convey a better apprehension of the nature of the mobilising force? They seem to imply a degree of effort that is most undesirable, and yet they convey the idea of suddenness to which it is essential to attain It is equally essential to catch the joint "unawares" so to speak, or, perhaps better still, "off guard"

Even the word "force" may itself be misleading, but there is no other word to express what is intended Anything like brute force should find no place in manipulative treatment it is possible that a light pressure with a finger-tip may serve to supply all the "force" that is required to attain the desired end, or, on the other hand, the full weight of the body may be necessary to secure our object Leverage is the main guiding factor as to the extent to which the exhibition of force is justifiable The application of anything like brute force is pregnant with evil, and yet it is often used when adequate knowledge of technique would enable the desired objective to be attained by means of a relatively insignificant pressure or pull Force can never in any circumstances replace technique when dealing with a joint by manipulation Indeed, the expenditure of any undue or unnecessary force is itself evidence of gross lack of technique Another proof of inefficiency is the holding of the breath while performing a manipulation This is entirely unnecessary, and, if the manipulator holds his breath, it almost always indicates that he is trying to secure by brute force an effect that could be attained with far less effort had he a better knowledge of technique The application of the least trace of unnecessary force involves a risk of inflicting unnecessary injury to the joint and therefore to the patient

The next important point is the question of leverage With regard to this, it is obvious that the shorter the leverage used, the more controlled is the force exerted This applies particularly to the breaking-down of adhesions Here the chief difficulty is to apply a force sufficient to break down the offending bands, and yet to keep that force under such control that the movement will cease the moment the band has yielded If the force is not under control, the bone that is being moved is liable to continue movement beyond the limit of normal physiological movement, and this must lead inevitably to unnecessary damage to normal structures It is, moreover, exceedingly important to know exactly where leverage is being used in the movement of

structures has deteriorated so far that it will be inadequate to allow the full range of movement. Any excess of zeal in treatment will therefore inflict a severe ligamentous strain, and this cannot improve, but can only prolong, and may perhaps even inhibit, convalescence. The situation may be summed up thus: it is far better to do less than we believe might safely be done, and so secure a relatively small, but real and continuing improvement, than to take any risk of doing too much, and perhaps gaining nothing for our patient, or even rendering his condition worse than before our treatment.

There are certain rules which always govern the actual details of the manipulation of any joint. The movement of a joint involves the movement of one joint surface upon another. If, therefore, we intend to move one joint surface, it is essential that the other should be fixed as far as this is possible; otherwise we can never be sure of the precise manner in which our mobilising force will be expended. As far as the joints of the extremities are concerned it is generally true to say that during treatment one hand of the manipulator stabilises while the other mobilises. If the stabilising hand fails to do its duty with efficiency, it follows that the force exerted by the mobilising hand is transmitted beyond the joint that it is desired to move, and so reaches other joints where it is expended uselessly or perhaps even detrimentally. It is extremely seldom that both hands can be used simultaneously as the mobilising force: then fixation must depend on other controlling forces.

There are, however, many joints within the body where it is impossible to secure a grip of one bone while we cause the other to move upon it. In this event the joints adjacent to the one that we wish to move must be held rigidly at the limit of their ordinary physiological range of movement. This gives us a fixed bone upon which to work, but the fixation is never quite so complete as when the bone which we wish to stabilise can be secured by a direct grip, and so we have to make sure that the mobilising force applied, and which of necessity must be transmitted to the fixed joint, will not strain it to an extent that will cause injury. A full knowledge of the limits of safety in the movement of this joint is therefore essential. It may happen, particularly when manipulating the joints of the spine, that the manipulation of one joint may be perfectly successful, but that, owing to neglect of proper precautions, an injury is done to adjacent joints, which may be more troublesome than the one we set out to cure.

Having, therefore, decided the exact nature of the movement which we wish to perform, and having secured adequate fixation either by a direct grip with one hand or by the posture of all adjacent joints, the next rule of treatment is to "take up the slack" and then push or pull. This "taking up the slack" is of vital importance to the success of all manipulation; it is the only means by which the manipulative force can be adequately regulated and controlled. A general pull from a point some distance away cannot possibly be a scientific method of freeing a joint, if only for this reason, that when the impediment to movement is overcome there is nothing to prevent the action of the mobilising force from passing beyond the limit of safety, perhaps inflicting a severe injury on normal soft parts. A "pump handle" action or

of the bone-setter and so impressive to the patient—at many of the joints in the body We have to determine the reason for these snaps and the value to be attached to them Many of us are able, without any difficulty, to snap the metacarpo-phalangeal joints at any given moment, but, once the snap has been secured, few of us are able to reproduce it until a very considerable space of time has elapsed—say twenty-four hours or so We have, therefore, one piece of knowledge about the snap that is irrefutable, namely, that the sound is produced when a joint is moved in a certain direction, provided that it has not been moved similarly for a considerable time Moreover, the snap (which, by the way, must be distinguished from a tendon snap) is produced during the performance of some movement which is not normally under voluntary control, or at least during a movement which, if under voluntary control, is very seldom used Needless to say, the production of the noise has nothing whatever to do with the "little bone" slipping back into place, or with the reduction of dislocation It can be produced perfectly readily in many joints in which no pathological lesion is present, and in spite of perfect health and continuous function It is perfectly plain, therefore, that the benefit of manipulation is not dependent on the securing of the snap, and, indeed, it sometimes happens that those who have such implicit faith in it will worry away at a joint in order to secure the snap until very much more has been done than is really desirable, and mischief ensues The exact nature of these snaps is unknown, certainly it has nothing whatever to do with the breaking-down of adhesions The most probable explanation is that during the performance of some movement which is not performed naturally by the patient's own muscles a vacuum is created within the joint more on one side than on the other, and that then, as traction is applied, there is a sudden readjustment of the synovial fluid within the joint As a result the capsule changes its position with an audible snap Fig 7 will be found to indicate diagrammatically what is meant

Fig 7 Diagram to show the most probable cause of the snapping within a joint which may take place during manipulation The movement performed is supposed to be that of traction when applied to the metacarpo phalangeal joint (*Cf* Figs 26 and 27 p 60) As the articular surface on the base of the phalanx is pulled away from that on the head of the metacarpal it is probable that the first effect is that the capsular ligament is pulled inwards throughout the circumference of the joint as the result of the decrease of hydrostatic pressure within the joint (See left side of diagram) The application of further traction then causes the ligament to straighten out all round (see right side of diagram) and *it is probably the sudden transition of the line of the capsule* from the curved to the straight that causes the snapping to be heard hence the expression vacuum snap of the capsule

Having, therefore, come to the conclusion that a snap can be secured within a perfectly healthy joint just as easily as, and perhaps more readily than, within one in which a lesion exists, the question arises whether we are

a joint, and where there is no call for the use of leverage. The point is, when no leverage is being applied, a degree of force may be exerted with safety which might inflict considerable injury were leverage being employed. Thus it is possible that during the manipulation of a single joint great force may be exerted during the performance of one movement, while the next must be performed with the utmost delicacy and finesse. Traction, for example, is to all intents and purposes always safe, subject to one proviso, namely, that we are careful to "take up the slack" before applying the pull. It is important to remember, however, that in applying traction the pull should always be as far as possible in a direction parallel to the main supporting fibres of the ligaments of the joint. Take, for example, the application of traction to the metacarpo-phalangeal joint. The traction applied should exert the force in one direction, and in one direction only, namely in the long axis of the phalanx. The force is then applied in the same straight line as that occupied by the lateral ligaments, and the fullest amount of traction that can be exerted will do no harm. If, however, the joint is stiff and somewhat flexed, any attempt to apply traction to the phalanx in the same straight line as the metacarpal means the exertion of leverage upon the shortened structures, and, therefore, traction is only to be applied with the utmost care. Indeed, it is doubtful whether in this particular instance mobilisation by traction is ever justified in the long axis of the metacarpal, whereas traction in the long axis of the phalanx, and therefore of the lateral ligaments, is safe and beneficial.

Continuing our consideration of the same joint, we find that the next movement to be performed, the antero-posterior movement of the base of the phalanx on the head of the metacarpal, exerts no leverage and so may be performed with considerable vigour. The next two movements, side-bending and rotation, form a sharp contrast to the first two. Both of these depend upon leverage for their effect, and, therefore, the force applied must be reduced materially and must be applied with a care which must be meticulous as compared with that necessary during the first two movements.

Passing to the shoulder joint, we find that in manipulation no leverage force is applied to any of the normal structures when pressing the head of the humerus upwards, forwards or backwards, or while pulling the head of the bone away from the glenoid. When, however, it comes to pressing it downwards, leverage is exerted, the utmost care is essential, and any force used must be under perfect control. Then when it comes to the performance of those movements which are under voluntary control, for example abduction of the shoulder, the leverage is shortened so as to reduce its effect to the smallest serviceable limit. In practice the most important result of these instructions is that the nature of the grip to be taken will vary entirely according to the answer to the question whether leverage is about to be applied or not.

The application of traction leads us to the consideration of another doubtful point, and that is the value which we ought to place upon the snap so often heard in various joints when traction is applied. Once the trick has been learned it is often possible to produce these snaps—so dear to the heart

there is nothing more to do at the moment It is worse than useless to try to force the joint to perform a movement which is limited either by normal ligaments or by pathological bands which it has already been decided not to free at this particular juncture Thus when manipulating an elbow having once secured full extension, there is no further impediment to extension, and there can be no object in repeating the movement If we do repeat it, it is extremely likely that irritation will be set up within the joint and far more harm than good will be done

We now come to the question of after-treatment, and of the extent to which it is wise either to move the joint the day after treatment or to encourage the patient to move it himself Many hold that it is an essential part of treatment to put a joint, on the day following manipulation through the full range of movement that the manipulation had secured This is perfectly justifiable provided there is no reaction that is to say, provided that the movement does not cause pain Where there is definite pain on movement one school of thought teaches that in spite of this the full range of movement must always be performed Now the very fact that pain occurs during normal movement means that there may be, and probably is some degree, however small of active inflammation within the joint or in the structures connected with it Pain on movement is synonymous with irritation, and for function to be restored at the earliest possible moment this irritation must be allowed to subside as quickly as possible This end cannot possibly be attained by the performance of movement which irritates, and which, therefore, only tends to maintain the inflammation or even to increase it

If a boy at school sprains his knee sufficiently badly to cause even slight effusion, there are very few people who would expect that boy to move the knee through the full range of movement until the fluid had subsided let alone on the next day, yet often enough, when effusion follows the manipulation of a knee, the patient is expected to perform the full range of movement the next day in spite of this obvious sign of some inflammatory process within the joint The result is that the fluid persists and recovery is slow and tedious On the other hand, it is becoming more and more generally recognised that complete rest is almost as undesirable as excess of movement in the treatment of recent injury, and we know that the performance of painless movement always tends to hasten repair

Therefore when a joint has been manipulated one day it is essential that it should be examined with meticulous care the next day, in order to discover the exact range of movement which can be performed without causing pain or distress Not only should this movement be performed, but its performance by the patient should be encouraged, and provided a range of movement can be found which is entirely free from pain, this should be performed by the patient constantly throughout the day However, the danger point of the onset of pain should be approached with the utmost caution, and if any pain is caused as the result of movement, it should be taken for granted that movement has been excessive and that something has been done which has given rise to irritation Adequate time with an appropriate degree of

justified in ignoring the snap altogether. Although the view of the snap held by many of the unqualified practitioners can only be described as fantastic, there would not seem to be justification for ignoring it completely. It shows, at any rate, that a joint has moved through a range of movement through which it had not passed recently. If there has been some lack of normal function within the joint, it is quite possible in suitable circumstances that the movement which has been performed, and which produced the snap, may restore a mobility which has hitherto been lacking and which has interfered with the normal functioning of the joint. In this event the snap may serve to a certain extent as a guide, but only as follows.

When we are examining the movements of a joint, and particularly those movements which are not under voluntary control, a sensation may be conveyed to the examining hands that all is not perfect within the joint. If the joint be then manipulated, and if the snap occurs as the result of the movement, it is always wise to re-examine the movements of the joint at once in order to ascertain whether the sensation which had suggested the possibility of imperfect movement can still be detected. Often enough the sensation conveyed before the snap took place will no longer be felt. The actual snap is of no importance whatever; the same beneficial result of movement would have been secured even though no snap had been heard or felt by either of the two parties concerned. Yet it cannot be ignored altogether, as it undoubtedly means that a movement has been performed which had not been performed recently, and the performance of this movement may lead on to the perfect restoration of the functional activity of the joint.

One word still remains to be said about the performance of those movements that are under voluntary control. If it is necessary to apply an external force in order that a movement should take place, the same rules will apply as in the case of movements which are not under voluntary control. The object is to apply the maximum of force which can be used without approaching too closely to the limit of safety. Leverage, therefore, should be as short as practicable, and having reached the existing limit of movement, the attempt to pass beyond this limit must be made firmly, but with the force under such perfect control that any sudden increase in movement can be held in check. If we are dealing with a pathological band we shall always attain better results if the band is broken sharply across by the first sudden application of the force directly it is applied. If the force is applied ineffectively, and the band is not torn, it will merely be irritated, and this irritation must cause some degree of inflammation, probably of the same type as the inflammation which originally caused the band to form. The worst possible form of manipulation when adhesions are present is a series of ineffective tugs. In other words, once having made up one's mind to perform a movement, the great rule is to perform it and to get it over. To be forced to make more than one attempt indicates an error either of diagnosis or of technique.

Having secured the desired range of movement, there can be no conceivable object in repeating it. If we have done the work efficiently and well.

out the day after manipulation adhesions will re-form, and the patient will lapse into the same condition as before the manipulation New adhesions do not form in a day, and why we should deny a reasonable degree of rest to a joint that has been manipulated and therefore probably irritated, it is difficult to understand After all, if adhesions have been present and have been broken down, some degree of trauma must have been inflicted and the patient has a joint which has suffered recent injury, moreover, the injured joint was not a perfect joint at the time the injury was inflicted Surely, therefore, it must be right to deal gently with it and at least to give it the rest and consideration which we should prescribe had an injury of similar severity been inflicted on a previously healthy joint

There is no escaping the fact that frequently patients, after a joint has been manipulated, come to us seeking advice as to what to do next because they find that after, it may be, weeks of intense pain, the condition of the joint is as bad as, or worse than, it was before the treatment The difficulty of persuading these patients to submit to a second manipulation is great, but if this difficulty is overcome and the second manipulation is successful, the delight they exhibit on finding that improvement has taken place with almost complete absence of pain is very pleasing to witness On the other hand, a case of this sort is devastating to the reputation of the person who performed the first manipulation and who inflicted such an enormous amount of totally unnecessary pain and failed equally to attain the desired objective

A final word must be said on the subject of function as an aid to the restoration of movement It was not until some fifteen years had elapsed after the publication of Hilton's classic essay on "Rest and Pain" that the genius of Lucas-Championnière conceived the essential distinction between rest from movement and rest from function We have already explained that movement begets movement and function begets function, it is no less true to say that function also begets movement This is the essential truth on which the science of occupational therapy is based No one would subscribe more readily than the present writer to the doctrine that, with regard to the ultimate restoration of full movement and of complete function, voluntary effort must always play a larger part than any other form of treatment, but there is, and always will be, a very important place in treatment apart from voluntary effort Moreover, voluntary effort must be properly directed, or it will be terribly wasteful and often even harmful Thus, after the manipulation of the shoulder when definite adhesions have been broken down, the amount of voluntary movement which a patient can perform recumbent is, as a rule, considerably in excess of that which can be performed in the vertical position with an equal amount of effort or of pain Postural treatment, therefore, is essential if voluntary movement is to be used to the best advantage In the direction of many other details connected with voluntary movement the trained physiotherapist is able to assist materially towards recovery Through fear of pain the patient is often reluctant to move the joint through the restored range of movement, and this, after all, is only

rest, must therefore be allowed to elapse for this added irritation to subside. Provided the irritation is very mild, the reaction will pass off in a few hours, and certainly in less than twelve. If, however, the reaction is severe, a longer time than this will be required.

Therefore the instruction which it is wise to give with regard to after-treatment is that movement within a painless range should be encouraged up to the limit of that range; that movement approaching a painful limitation should be performed not more than twice a day, and that the movement should cease directly definite pain is noticed. If this plan is followed out day by day the painless range of movement will be found to increase rapidly and the painful limit to decrease. In this way we are able to lead on from good to better. If, on the other hand, we insist on movement in spite of pain, we run a considerable risk that the irritation will be maintained, and chronic irritation, as we all know, is one of the most potent causes of the formation of adhesions.

So cases occur in which irritation, due to faulty treatment, is maintained within a joint after manipulation; not only is the result complete failure, but the patient may find himself in a condition worse than before the manipulation was performed.

On the other hand, we must remember that each individual has his own interpretation of the word "pain." One patient, who has slept most of the night and had a good breakfast, will assure you with a happy smile that she has been in agony all night, and that it was only as the result of a wonderful sleeping tablet that nurse had given her that she went to sleep at all. The fact that the tablet may have contained nothing but soda-mint is a point that is overlooked. Faith in the remedy is often the deciding factor rather than any particular merit the remedy may have. Yet with pain after manipulation it is better to err on the side of over-medication rather than under, in the first instance, at least, and if pain is at all a prominent feature, some preparation of opium or its derivatives is the only remedy that will abolish it adequately. Then, on the other hand, we encounter the heroic soul who has really suffered severely through most of the night in spite of hypodermic injections of morphia, and who looks pale and haggard the next day. This hero will often assure you that "it is not too bad," and will promptly move the limb through a range of movement which obviously causes acute pain. The treatment of these two types must, of course, be diametrically opposed: the one needs encouragement; with the other it is essential to "put on the brake."

In the after-treatment, no less than in the performance of the manipulation, both tact and discretion are needed. Fortunately we have safe and certain guides; provided the range of painless movement increases day by day all is well; if it does not so increase, and increase noticeably, something is definitely wrong, and either too much was attempted at the time of the manipulation, or medication was inadequate, or else the patient in his zeal for improvement has been exceeding the instructions given him.

It is a common delusion that unless the full range of movement is carried

the joint on the following night through the maximum range of movement that is possible without undue pain

It is, of course, possible for a patient to do too much, and it is often difficult to judge whether or not he has done so It is only possible to give an empirical guide We may say with reasonable safety that, if a movement causes pain in a joint, which persists for more than half an hour after the joint has been placed at complete rest, too much has been attempted If, however, all pain and discomfort disappear within a few minutes of the joint being placed at rest, nothing has been done which will cause any deleterious irritation In the case where the pain persists for over half an hour, repetition of the movement which caused it should be postponed for at least twelve hours, but this must not be taken to mean that lesser and painless movement should also be avoided

It is needless to say that function must be prescribed at the earliest possible moment As far as the extremities are concerned the best function is invariably secured by employing both limbs at the same time, this at least applies to the performance of all coarser movements Thus, for instance, manipulation of a patient's hand the fingers of which have been very stiff, will only secure that the first dead point shall be passed and although after the manipulation the range of voluntary movement will have increased, the increase may not be of any great practical service for the ordinary usages of life Probably the quickest and most efficient way of restoring function is, in the first place, to warm up the injured hand and one very effective way of doing this is by use of the warm wax bath Then the joints are put through those movements which are not under voluntary control, and assistance is given to help in the performance of those which are If the patient can then be encouraged to use a pair of large spring shears, such as are used by gardeners for clipping the hedge or a grass edge, the function will be found to return far more rapidly than if the patient is merely encouraged to open and shut the fingers without any definite purpose So, too, if the patient can secure comparative privacy, practising on a piano or other musical instrument is often of great service A typewriter is a useful substitute Again, in the after-treatment of a shoulder or even of wrist or fingers, learning to swing Indian clubs with both hands is far more effective than attempting to do the same thing with one hand only

When we come to the treatment of the joints of the lower extremity it must be remembered that balancing is far more important than movements which entail more vigorous effort Thus it may well be that balancing on the injured limb while exercising the sound limb by movements off the ground may be of greater value than set exercises designed to improve the muscle strength of the injured limb

Finally, it must always be kept in mind that the function of the joints of the lower extremity almost invariably involves the use of the weight-bearing function To prescribe the use of this function while active inflammation is still present within a joint is always calculated to maintain the inflammatory process, not to decrease it, therefore until all trace of

natural. Our power of co-ordination of movement is controlled by the muscle and joint senses, both of which are dependent upon the efficient working of very highly developed reflexes, which, being developed relatively late, are all the more easily disturbed or lost. It is irrational to suppose that after, it may be, several months of inhibition, so delicate a mechanism as that of these reflexes could be restored at a touch; yet, until they are restored, recovery must inevitably be checked. Hence it comes about that, if there is any trace of reaction after manipulation, steps should be taken as soon as possible to counteract the baneful effect of this reaction on the joint and muscle senses. The reaction of muscles to pain on movement of a joint is one of protective spasm, and the best antidote for this is sedative massage. When the power of active relaxation is restored to the muscles, painless passive movement will pave the way to painless active movement. This in turn will beget a wider range of movement and so the recuperative course can be carried on. It is thus that the whole realm of physical treatment can properly be invoked to assist in the process of recovery. If the patient is left to his own devices, it is inevitable that the best chance of recovery will be lost.

When speaking of passive movement in this connection, we mean by this term the true passive movement as understood by the physiotherapist. For passive movement of this type there must be complete voluntary relaxation of all the patient's muscles, and this relaxation is impossible unless the movement is completely painless. Passive movement, as all those engaged in physical treatment must know, is never an end in itself, but is merely a step towards voluntary movement; which again is only a means by which the ultimate objective—the restoration of function—may be secured.

When, therefore, treatment is applied the day after manipulation, massage is administered as may be necessary to secure the first stages of passive movement. These having been secured, we lead on by means of assisted movements to free voluntary movement. Having found the limit of painless voluntary movement, every attempt should be made to secure complete relaxation of the muscles by means of posture and massage, and then it may be found possible to lead the part through an increased range of movement; after this, as movement begets movement, it will be found that the painless range of assisted movement has increased, and, by means of this, the painless range of active movement is also increased. So we go on until no further increase of painless active movement can be secured.

Unless the reaction is considerably more severe than it should have been after manipulation, *i.e.*, unless too much has been attempted at the time of the manipulation, or the wrong time has been chosen to perform it, there should always be some very definite range of completely painless voluntary movement. This the patient is instructed to perform constantly throughout the day. As soon as a painful limit is reached movement should be restricted until painless movement becomes once more possible. However small the range, movement will beget movement and the range will steadily increase. The patient should then be instructed in the most favourable posture in which movement can be performed, and should be invited to lead

needed is to tighten a few cords and any part of the body, and even the whole body, can be supported in any position that seems to be the best for the patient There is one method of treatment that has proved to be of the utmost service, namely the stretching of the spinal column Various tables have been built for carrying this out, but although the traction applied is adjustable, once it is set for a certain traction no further alteration can be made until the apparatus has been running for a considerable time With the Guthrie-Smith apparatus, it has proved possible, by fixing the head or the pelvis to one end of the apparatus, to exert a corresponding traction by means of a strap placed round the operator's back, who, by swaying the body to and fro, can transmit the same intermittent traction, but with this great advantage that the strength of the traction can be modified by increase, decrease or frequency every time the motive force is applied (See Fig 8) The movement, therefore, is much more under control and the amount of fatigue to the operator is almost negligible after a little practice The relative cost of this apparatus is, of course, quite insignificant when compared with the installation of any form of bath treatment There can be little doubt that there is a great future before treatment with this type of apparatus,

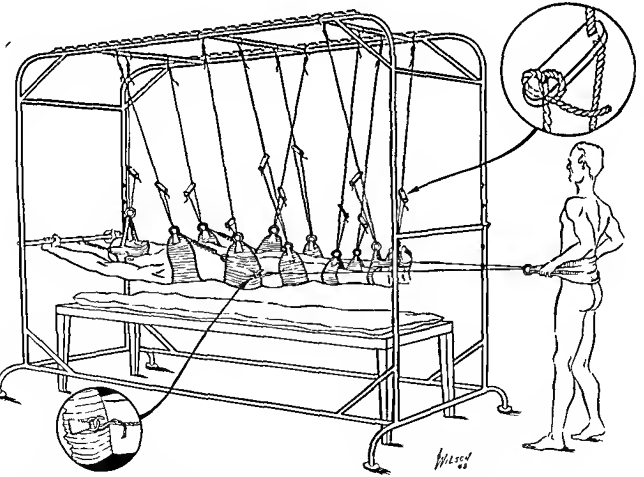

Fig 8 To show how the Guthrie Smith apparatus can be used for applying traction to the joints of the spinal column generally the head being fixed

inflammation has subsided, it is well to encourage movement without weight in preference to movement which involves weight-bearing. Here then we see the great value of exercise on a sliding seat or on a bicycle.

Something must also be said about assisted movement when the assistance is given by water. Movement in a hot bath will, as everyone knows, almost invariably tend to relieve stiffness and assist in the restoration of movement. The earlier this can be prescribed, the better. In the later stages, however, when we are anxious to see how far the patient can improve as the result of voluntary movement before deciding whether a second manipulation will be necessary or not, there is no really efficient substitute for the Brine Swimming Bath at Droitwich. In the final chapter reference will again be made to this when dealing with the treatment after manipulation of osteo-arthritis of the hip joint; but, because special emphasis is laid upon this condition, it must not be understood that it is by any means the only type of case in which exercise in the Brine Bath is of service. It is of the greatest value in cases in which relief has been sought by manipulation of the joints of the spine; and after manipulation of any of the joints of the lower extremity suitable exercises definitely prescribed in the "swim" at Droitwich are always useful. This is also the case even where the joints of the upper extremity are concerned, and particularly after manipulation of the shoulder joint. For elbow, wrist and the joints of the hand, the Brine Bath is not of the same service, its utility decreasing for each joint in the order they have been named. Similar remarks apply to the joints of the lower extremity.

In some cases exercise in an ordinary swimming bath or swimming pool will serve our turn. Better still is swimming in sea-water, but there can be no comparison between even this and the "swim" at Droitwich, though, unfortunately, it is sometimes difficult or even impossible to persuade patients to go there. It may, however, be said that, if after-treatment at Droitwich is possible, it is undoubtedly wise to prescribe it—not, it is true, as an essential part of treatment, but as extremely desirable in practically every case where the hip joint has been manipulated, and in many cases where the joints of the spinal column below the mid-thoracic region have been freed of adhesions by manipulation. If no definite adhesions have been broken down, and if mobility has been restored without the necessity of breaking adhesions, the value of the Brine Bath materially decreases, and only in certain special cases need under-water treatment be prescribed.

Of recent years, and more universally in the United States than at home, water-tanks are provided for under-water treatment and apparently with considerable benefit to the patients for whom it is prescribed. There is, however, this one great disadvantage, namely, that the patient can only use it, as a rule, once a day. We owe it to Mrs. Guthrie-Smith, M.B.E., F.C.S.P., that we now possess an ingenious apparatus known by her name, which consists of a means of eliminating gravity by means of adjustable slings. The great advantage of this treatment is, of course, that it can be repeated at frequent intervals throughout the day as the only preparation

needed is to tighten a few cords and any part of the body, and even the whole body, can be supported in any position that seems to be the best for the patient There is one method of treatment that has proved to be of the utmost service, namely the stretching of the spinal column Various tables have been built for carrying this out, but although the traction applied is adjustable, once it is set for a certain traction no further alteration can be made until the apparatus has been running for a considerable time With the Guthrie-Smith apparatus, it has proved possible, by fixing the head or the pelvis to one end of the apparatus, to exert a corresponding traction by means of a strap placed round the operator's back, who, by swaying the body to and fro, can transmit the same intermittent traction, but with this great advantage that the strength of the traction can be modified by increase, decrease or frequency every time the motive force is applied (See Fig 8) The movement, therefore, is much more under control and the amount of fatigue to the operator is almost negligible after a little practice The relative cost of this apparatus is, of course, quite insignificant when compared with the installation of any form of bath treatment There can be little doubt that there is a great future before treatment with this type of apparatus,

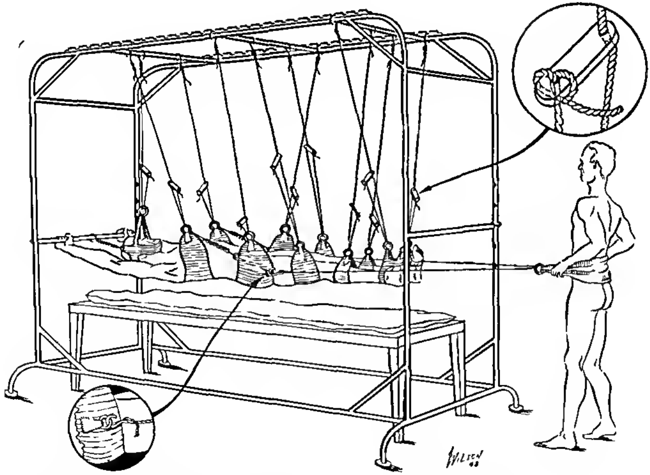

FIG 8 To show how the Guthrie Smith apparatus can be used for applying traction to the joints of the spinal column generally the head being fixed

provided that the use is not carried on indefinitely. As soon as the patient can perform any of the ordinary gymnastic and other mobilising work, weaning from the apparatus should proceed as rapidly as possible, with the one exception of continuing the use of the apparatus as a means of applying traction. Yet when all is said and done, there can be no doubt that no artificial means can replace, or in any way equal, the ordinary movements commonly performed when sea-bathing, but for this a marked degree of convalescence must have been reached, and something has been needed (which we now possess) to provide for the elimination of gravity without the use of under-water treatment at all.[1]

[1] The book on the use of this apparatus is entitled "Rehabilitation, Re-Education and Remedial Exercises" and is published by Baillière, Tindall & Cox, London

PART II

THE JOINTS OF THE UPPER EXTREMITY

CHAPTER V

THE DIGITAL JOINTS

Anatomical Considerations

THE metacarpo-phalangeal metatarso-phalangeal and inter-phalangeal joints are all so similar that they may be considered together Any modification applicable to an individual joint will be so slight that the main principles governing the movement or manipulation of one will be found sufficient guide for all The chief exception will be found in the rotation of the terminal phalanx on that which is proximal to it

When we examine the articular surface of the head of one of the metacarpal bones and compare it with that of the phalanx which lies in contact with it, a most striking difference is at once visible (See Fig 9) The articular surface on the base of the phalanx is not only much smaller than that on the head of the metacarpal, but it is also of entirely different shape A glance at Fig 9 shows at once that only a very small portion of articular cartilage on the head of the metacarpal can be in contact with that on the base of the phalanx at any one time Yet articular cartilage can never be redundant and therefore, in ordinary life, there must be occasional use at least for the relatively large articular area on the metacarpal head In other words, the base of the phalanx must slide over and around the head of the metacarpal in all directions and must come in contact, even if only occasionally, with every part of the metacarpal articular surface Moreover, the ligamentous attachments must be so arranged as to allow for the perfect freedom of these sliding or gliding movements

FIG 9 Drawing of the articular surfaces of the head of a metacarpal and of that of the base of the proximal phalanx seen from the lateral aspect The expanse of the former is far greater than that of the latter Note also that the articular surface on the head of the metacarpal extends somewhat on to the dorsal aspect thus allowing for a definite degree of hyper extension

The fact that the articular surface on the head of the metacarpal extends over the top of the bone towards the dorsal aspect proves that some degree of hyper-extension beyond the straight line was possible in the joint from which the drawing was taken This varies in

different individuals, not with the shape of the phalangeal facet, but with the extent to which the metacarpal facet extends backwards over the top of the bone. The palmar aspect of the metacarpal facet does not seem to vary to any noticeable extent, and the degree of flexion—in health—is comparatively constant.

Seen from the side, the articular facet on the head of the metacarpal is rounded, but its outline does not follow the arc of a true circle. There is a slight flattening of the arc of the circular contour on the distal aspect. (See Fig. 5, p. 17.) Thus in full extension—which is usually the equivalent of full hyper-extension—the lateral ligaments are taut, but directly flexion begins the traction on these ligaments is relaxed and a range of movement becomes possible which is quite impossible while the ligaments are taut. These simple anatomical facts have a profound bearing on both the physiological movements, and on the technique of manipulation, of the joints.

We have already seen that, during the movement of flexion from full extension, the base of the phalanx glides over the head of the metacarpal

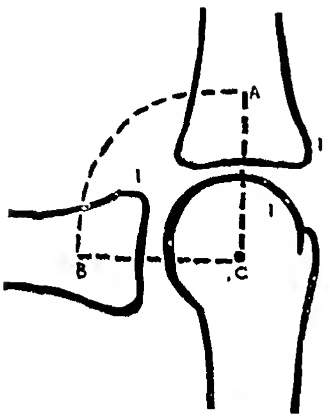

FIG 10 To show the alteration in position of the base of a phalanx on the head of a metacarpal when it passes from extension to flexion The letters show the extent of the movement Note how the figure 1 near the posterior aspect of the base of the phalanx has moved well away from 1 on the metacarpal during flexion, though opposite to it in extension

The movement of the base of the phalanx on the metacarpal head is shown diagrammatically C the metacarpal origin of the lateral ligament, C A. and C B the lateral ligament in extension and flexion respectively, A the phalangeal insertion, A B′ the arc through which the phalangeal insertion passes in flexion or extension (*Cf* Fig 44, p 68) The slight flattening of the top of the metacarpal head is shown more plainly in Fig 41, p 67

forward and downward towards the base of the metacarpal. Something must guide and control the movement, and this "something" is the lateral ligament on each side. Thus with the metacarpal origin of the lateral ligament as centre, and with the phalangeal insertion of the ligament as the terminal point of the radius, the phalangeal insertion describes an arc which is approximately an arc of a circle during flexion and extension. (See Fig. 10.) If the movement were not almost circular there must be some point or points during the movement at which either the ligaments would be so taut that the joint surfaces would be drawn together with a force that would arrest all movement, or else would be so slack in other positions that stability would be lost to a deleterious extent. Since, however, the head of the metacarpal, though nearly spherical, is not exactly so, it follows that the ligaments are not taut to the same extent throughout the whole range of movement. In full extension they are relatively taut, but the moment flexion begins they are relatively slackened. Then the tautness returns as flexion advances to the full. It is difficult to demonstrate this point, but the examination of the movements that are not under voluntary control indicates that it must be so. Moreover, the movements of adduction and abduction

are reduced to a minimum when the lateral ligaments are taut in extension (see Figs 11–14), and this in spite of the fact that the widest abduction of the fingers is apparent when the fingers are at full stretch in voluntary extension—not necessarily even in full anatomical extension This is due

Fig 11 X ray examination of the metacarpo phalangeal joint of the middle finger to show how the movements of adduction and abduction of the fingers are performed In Figs 11 and 12 the range of movement of the phalanx on the metacarpal is shown when a slight degree of flexion is allowed This figure shows ulnar adduction

Fig 12 This figure compares with Fig 11 showing radial adduction

Fig 13 To show the contrast when the metacarpo phalangeal joint of the middle finger is fully extended and an attempt is made to perform the movement of ulnar adduction This figure contrasts with Fig 11

Fig 14 This figure is the contrast to Fig 12 when an attempt is made to perform radial adduction at the metacarpo phalangeal joint when this is fully extended Note that little movement is seen to have taken place at the metacarpo phalangeal joint in Figs 13 and 14 when compared with Figs 11 and 12

to two facts, first that the flattening of the metacarpal arch alters the "set" of the heads of the metacarpals and thus alters the plane of the surfaces with which the phalanges articulate so as to render the range of separation of the fingers from one another a part of normal metacarpal movement, and, second, that the range of movement of the metacarpal heads away

from one another is greatest when the arch of the metacarpal heads is flattened, thus again altering the "set" of the surface on which the base of each phalanx rests. To prove this all that is necessary is to extend the fingers to the full extent, separating them as far as possible. Now an effort is made to approximate the fingers to one another without allowing the metacarpal arch to curve. Little or no approximation occurs. Now allow a minute degree of flexion at the metacarpo-phalangeal joints and also the curve between the heads of the metacarpals to re-form, and the adduction at once becomes quite a simple matter.

The lateral ligaments of the metacarpo-phalangeal joints have received main attention, as the capsular ligaments can have no stabilising influence

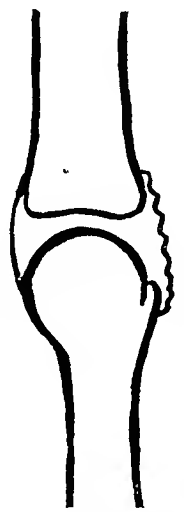

FIG 15 Diagrammatic representation of the plication of the capsule of a metacarpo-phalangeal joint during the extremes of movement This plicating must invariably be present in every joint in which a wide range of gliding movement is present This figure shows the plicating at the back of the joint in extension, the ligament on the anterior aspect being taut

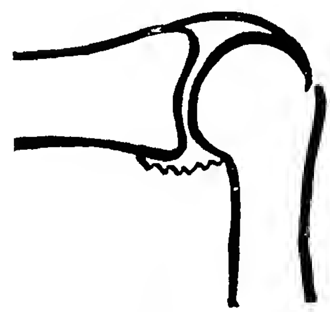

FIG 16 To show the plication of the capsule which takes place in flexion of a metacarpo-phalangeal joint, it is now taut on the posterior aspect

on the joints. Of necessity the latter must be relatively slack except at the limits of movement, when they are taut on one side of the joint and slack on the opposite side. (See Figs. 15 and 16.)

The practical application of these purely anatomical and physiological facts is that they serve to explain certain other facts which otherwise are hard to understand. If, during a stage of active inflammation, the fingers have been kept even slightly flexed, the formation of adhesions in the lateral ligaments, or any loss of elasticity, must render full extension impossible until the adhesions are overcome and the elasticity is restored sufficiently to allow the stretching that takes place during the passage from the slightly flexed to the fully extended position. When, however, a finger has been allowed to stiffen with the joints straight or hyper-extended, the difficulty in overcoming the impediment to flexion cannot rest in the lateral ligaments. Now it is a question of the matting together by adhesions of the folds of the posterior part of the capsular ligaments. (See Figs. 15 and 16.) This is

regardless of the possibility of the formation of adhesions in the tendon sheaths

Finally, we must not forget the importance of the elasticity of the skin in the webs between the fingers Even when this is perfect it acts as a check to certain movements For instance, so far as the joints are concerned there is no apparent reason why, when the annularis is held in hyper-extension, there should be any limitation of flexion in medius or minimus at the metacarpo-phalangeal joints Yet, as is well known this limitation does exist and, as can be seen in Fig 17, it is mainly due to the skin of the webbing between the digits

It seems appropriate to consider here one more point of practical import The plane of movement of the metacarpo-phalangeal joints is simply antero-posterior during flexion and extension—yet during natural extension from a position of flexion of each individual digit at all joints the phalanges stretch out away from one another in abduction The main mechanical cause of this movement as has already been noted, is the flattening of the metacarpal arch When full extension, or hyper-extension, is reached the digits cannot be approximated to one another until the arch of the metacarpal heads is allowed to reform Then, while re-forming, the set of the metacarpal heads alters and the phalanges approximate in flexion until abduction in the flexed position becomes impossible The lateral ligaments being fully taut in hyper-extension and in full flexion the movements of abduction and adduction in these two positions are reduced to zero Thus the full range of adduction of the fingers in full flexion and of their abduction in full extension is really dependent on the integrity of the movement of the joints at the bases of the metacarpals (*Cf* Figs 48–51, p 70)

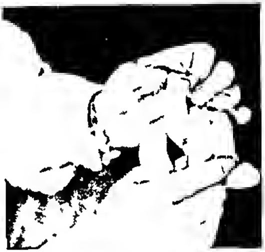

FIG 17 To show how the skin of the web of the finger at the base of the annularis limits flexion of both medius and minimus when the annularis is held in hyper extension

The alteration of the "set" of the metacarpal heads has another important effect on the movement of the digits, simple but necessary, and of vital importance to function, and therefore of equal importance when considering the question of mobilising the joints Thus, if each individual finger is flexed towards the palm until it comes in contact with it, it will be found that the tip of each comes to rest while pointing to identically the same spot, namely, towards the tubercle of the scaphoid (See Figs 18 and 19) When all are closed together as each finger tends to point to the same spot, it necessarily follows that they must be, as it were, glued together in full flexion This simple physiological fact leads on to two practical considerations first that, when attempting to restore the movement of flexion at a metacarpo-phalangeal joint, the direction of the pressure over the back of the phalanx

from one another is greatest when the arch of the metacarpal heads is flattened, thus again altering the "set" of the surface on which the base of each phalanx rests. To prove this all that is neeessary is to extend the fingers to the full extent, separating them as far as possible. Now an effort is made to approximate the fingers to one another without allowing the metacarpal areh to curve. Little or no approximation oceurs. Now allow a minute degree of flexion at the metaearpo-phalangeal joints and also the curve between the heads of the metacarpals to re-form, and the adduction at onee becomes quite a simple matter.

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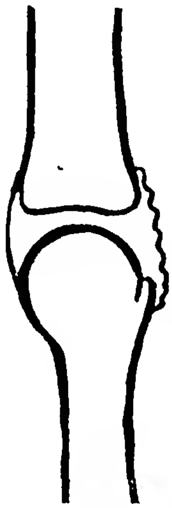

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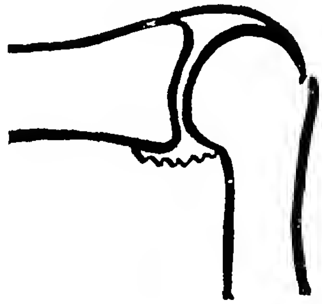

FIG. 16 To show the plication of the capsule which takes place in flexion of a metacarpo-phalangeal joint it is now taut on the posterior aspect

on the joints. Of necessity the latter must be relatively slack except at the limits of movement, when they are taut on one side of the joint and slack on the opposite side. (See Figs. 15 and 16.)

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laid upon the lateral ligaments on the radial sides of the joints. These then tend to stretch and the proximal phalanges assume a position of fixed ulnar adduction. Now the index, lacking support on the inner side from the medius, tends to follow it, and so the adducted position becomes general throughout the hand at these joints.

This leads to two very practical considerations: first, that, during the active stage of inflammatory conditions within these joints, it is wise so far as is possible to prevent continuous and simultaneous flexion of all the fingers. The second point is more difficult. To splint these joints in the extended position when actively inflamed may well be disastrous as regards the ultimate restoration of function. This is due to one of two causes, or to both. The tendency of ligaments is to shorten permanently, as elasticity always degenerates in the absence of movement, more particularly so if an

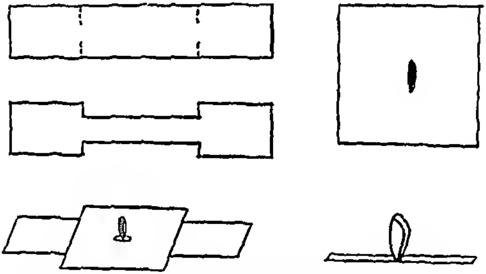

FIG. 21. Diagram to show the method of preparing loops to secure flexion of the fingers. The method of applying continuous and intermittent traction respectively is shown in Figs. 22 and 23.

inflammatory process is going on. There will also be a tendency for the formation of adhesions between the plications of the capsule. (See Figs. 7, p. 41, and 15 and 16, p. 54.) If, however, in addition to splinting the digit, straight continuous traction is applied, there can be no fear of the ligaments shortening or losing elasticity to any material extent. Also, as the capsular ligament is held fully stretched, adhesions cannot form between the plications of the capsule. (*Cf.* Figs. 15 and 16.) Thus by maintaining continuous traction, when it is impossible to retain a degree of movement which would be adequate to maintain elasticity intact, it may be possible to avert permanent injury; and, when the inflammatory process has subsided, there should be no great difficulty in regaining lost movement.

When flexion has been lost it is customary to try to restore it by means of continuous tension. The simplest method is by the application of loops made of adhesive strapping attached to the distal end of the finger and the palm and joined together by tapes or string. The exact position of the

FIG 18 To show how, during normal flexion of the index finger, the terminal phalanx points directly towards the tubercle of the scaphoid

must vary with the position of the head of the metacarpal. Thus, if the joints at the base of the metacarpals are stiff so that the arch is flattened, the pressure over the back of the phalanx should be directly antero-posterior. If, however, the bases of the metacarpals are free to move, then the direction of the pressure, while still remaining vertical to the long axis of the shaft of the phalanx, must be directed obliquely across the palm towards the tubercle of the scaphoid. (See Figs. 18 and 19.)

The second practical consideration is that we have here the explanation of the invariable adduction deformity of the metacarpo-phalangeal joints when these joints have been severely affected with a general arthritis. When these joints are inflamed, and when the capsular ligaments are distended with fluid, the natural position of rest is one of partial flexion. But all flex together, and there is no room at any one point for all the finger tips. Therefore the inner fingers are pushed away to the ulnar side (see Fig. 20), and no longer point to the tubercle of the scaphoid. They are therefore held over in ulnar adduction and thus chronic strain is

FIG 19 To show how the phalanx of the fifth finger, corresponding to that of the first in Fig 18, points to the same spot in flexion Note the difference in obliquity across the palm of the two fingers in flexion This obliquity is greatest for the fifth finger, and the obliquity decreases progressively as we examine the position of the fourth, middle and index fingers in flexion

FIG 20 To show that, when all the fingers are clasped in full flexion together, the tips of the three inner fingers are, as it were, pushed away from the point to which each would point were it flexed individually Compare the position of the tip of the fifth finger in this photo with that shown in Fig 19 It will be seen that the tip of this finger is now held over in relative ulnar adduction

fore-arm A second loop is prepared in the same way, but now the two adhesive surfaces at each end are left considerably longer These are divided down the middle to within a quarter of an inch of the piece that has been prepared as a loop The latter is then placed in the same straight line as the distal phalanx and each of the four loose ends in turn are secured as tightly as possible round the distal phalanx The tape must be long enough to be able to bandage the phalanx completely round, and not less than one and a half times

Now the two loops are joined together by tape or string If continuous tension is required—and this is usually the first stage—the two loops are approximated to one another as closely as possible without undue discomfort The position of the wrist is immaterial Not later than two days subsequently the tape or string will require tightening and this must be repeated until the two loops are in contact with one another Then the loop over the scaphoid is replaced by another one on the front of the fore-arm in the position already described, and the two loops are again approximated toward one another, but now the tape must be secured with the hand in palmar flexion The result is that every time the hand is moved up in the direction of dorsi-flexion, the tape tightens and in this way an intermittent tension can be made on all the joints of the digit The difference between the two attachments is shown in Figs 22 and 23

Movements Not Under Voluntary Control

Traction

The stabilising hand secures a grip by passing the first finger between the thumb and the first finger of the patient The thumb of the stabilising hand then rests across the back of the patient's hand, the fingers drop naturally into position and the base of the hand is so arranged as to rest firmly against the side of the patient's wrist joint (See Fig 24) The grip of the digit by the mobilising hand is taken which can best be described as the "golf-club" grip It is secured by wrapping, as it were, the fingers around the digit so as to enclose it when the fingers are in full flexion The thumb plays no part at all The stabilising hand carries that of the patient up against the manipulator's chest (see Fig 25), or, if the patient is recumbent, down to the surface of the couch, against which it is firmly pressed Then fingers, wrist and elbow of the mobilising hand are fixed as a bent and rigid lever , traction is applied by movement of the shoulder and thus the slack is taken up When the limit of movement is reached any extra traction applied will serve as the mobilising force The extent to which the base of the phalanx can be pulled away from the head of the metacarpal in any ordinarily supple adult is shown in Figs 26 and 27 Rotation of the trunk may be used as the mobilising force

It must be remembered that Figs 26 and 27 like all the other X-ray photographs shown of these movements, represent the degree of movement that is present in a normally healthy adult The model whose joints are shown was chosen quite by chance because she happened to be present with me in the X-ray Department at St Thomas's Hospital when I went there

palmar loop should depend upon the degree of mobility at the bases of the metacarpals: if these are free to move the palmar loop must be placed directly over the tubercle of the scaphoid, whichever individual finger it may be desired to flex. The tension thus exerted is a continuous one. If, however, it is desired to exert an intermittent tension, the loop, instead of being attached near the tubercle of the scaphoid, is fixed at a point proximal to the wrist; every movement of the hand upon the fore-arm then varies the tension of the band joining the two loops together. A simple method of preparing these loops is shown in Fig. 21, while Figs. 22 and 23 show the arrangement of the loops when applying continuous and intermittent tension respectively.

FIG 22 To show the application of loops and tape to secure continuous traction on the two proximal joints of the little finger (*Cf* Fig 23)

FIG 23 To show the method of applying intermittent traction to a finger by means of loops and a tape.

The top figure on the left in Fig. 21 represents an ordinary piece of adhesive plaster about 6×1 in. The dotted line represents four cuts, with a pair of scissors so that the central part can be folded over on each side, the adhesive surfaces being in contact with one another (see middle figure on left). This leaves two uncut pieces of adhesive which are approximated to one another as in the lower drawing on the right. We now have a loop through which tape or string can be passed without difficulty, but before doing so, a square is cut of another piece of 2-inch adhesive plaster. This is then folded with the sticky side outward and a piece is removed with scissors large enough to accommodate the loop on the former piece (see top figure on the right). The loop is then passed through the hole in the square piece, all the adhesive surfaces facing away from the apex of the loop. This is shown on the lowest figure on the left. The loop is then fixed firmly over the tubercle of the scaphoid or over the front of the lower end of the radius about an inch proximal to the skin crease on the palmar aspect of the

fore-arm A second loop is prepared in the same way, but now the two adhesive surfaces at each end are left considerably longer These are divided down the middle to within a quarter of an inch of the piece that has been prepared as a loop The latter is then placed in the same straight line as the distal phalanx and each of the four loose ends in turn are secured as tightly as possible round the distal phalanx The tape must be long enough to be able to bandage the phalanx completely round, and not less than one and a half times

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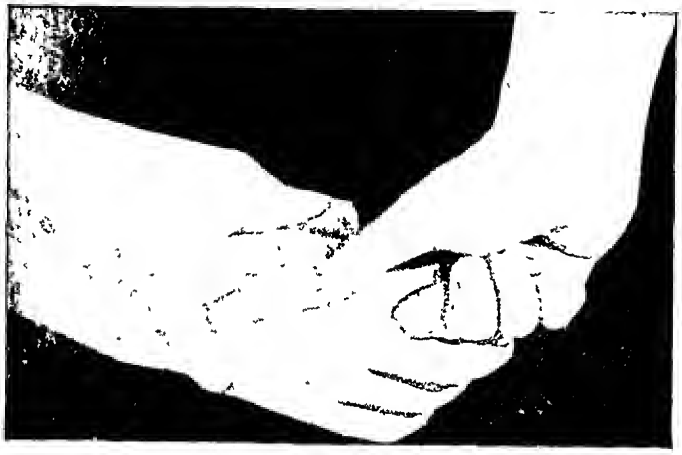

FIG 24 To show the "golf-club" grip for exerting traction on a finger in the long axis of the lateral ligaments of the joint between the phalanx and the metacarpal (*Cf* Figs 25, 26 and 27)

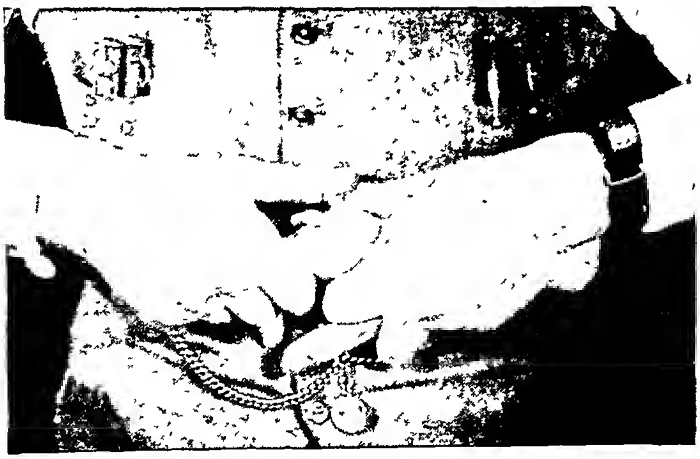

FIG 25 To show how the stabilising hand and that of the patient can be further stabilised by pressing them both against the chest of the manipulator

FIG 26 To show the relative position of the base of a phalanx and the head of a metacarpal before traction is applied (*Cf* Fig 27)

FIG 27 To show the amount of separation that takes place between phalanx and metacarpal as the result of traction (Contrast with Fig 26)

to discuss the possibility of showing these movements by means of X-ray photographs But all the photographs could not be taken in one series and from time to time it became desirable to supplement those already taken with others In no case has any deliberate selection of model been made, any volunteer would have been equally acceptable so far as concerns illustration of the range of movement which it is possible to secure

One word of warning is necessary concerning the direction of the pull of the mobilising force It is essential that this should be in the long axis of the lateral ligaments regardless of the direction in which these ligaments may point Thus, if mobility is reasonably free the pull may be directly in the long axis of the metacarpal, if, however, the joint is flexed and cannot be extended to the point where the phalanx and metacarpal are in the same straight line, then the line of pull of the force must follow the long axis of the phalanx, even though the resulting pull may be set at an oblique angle to the shaft of the metacarpal No leverage is exerted and so the mobilising force can be expended freely

Antero-posterior Movement of the Base of the Phalanx on the Metacarpal

In full extension this movement is completely lacking owing to the fact that the lateral ligaments are too taut to allow it to take place As flexion increases beyond an angle of about 30° from full extension the freedom of mobility, which was secured as flexion commenced, again begins to decrease, until, as full flexion approaches, it ceases altogether The stabilising hand assumes a very similar grip to that taken up when performing traction, the only difference is that now finger and thumb grasp the shaft of the metacarpal as near the head as is reasonably possible (See Figs 28 and 29) The mobilising hand grips the shaft of the phalanx in such a position that the thumb rests over the back of the bone, and so that the distal phalanx is parallel with the shaft of the bone and pointing upwards towards the fore-arm The first finger, curled up, lies over the front of the shaft of the phalanx near its base and to all intents and purposes transversely to it The stabilising hand then fixes the patient's hand, wrist and fore-arm as before, while fingers wrist and elbow of the mobilising limb are held rigid The base of the phalanx is then pressed directly to and fro upon the head of the metacarpal, the mobilising force being derived from the shoulder The range of movement which can be secured with a very slight degree of flexion is surprising The extreme positions are shown in Figs 30 and 31 No leverage is exerted, and so it is safe to exert a considerable mobilising force This is exerted, as when applying traction, by shoulder movement This, however, cannot be applied during this movement with the same unrestricted freedom as when applying traction since the nature of the grip of the mobilising hand is not so powerful

It is a common error to apply traction during the performance of this movement This is a serious fault in technique, rather should there be a slight tendency to press the two bones towards one another Thus, as the

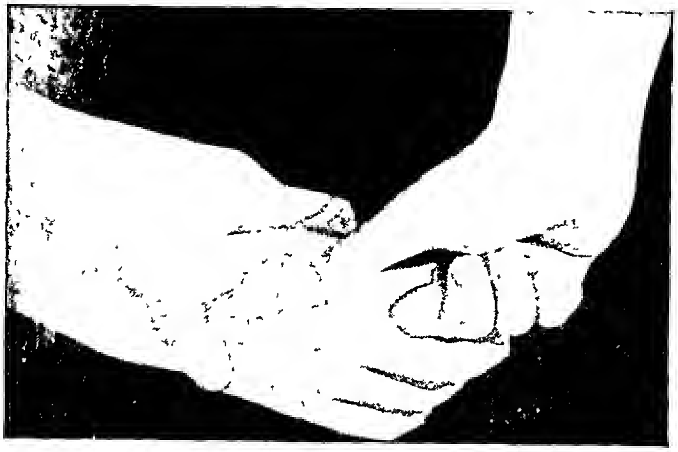

FIG 24 To show the "golf-club" grip for exerting traction on a finger in the long axis of the lateral ligaments of the joint between the phalanx and the metacarpal (*Cf* Figs 25, 26 and 27)

FIG 26 To show the relative position of the base of a phalanx and the head of a metacarpal before traction is applied (*Cf* Fig 27)

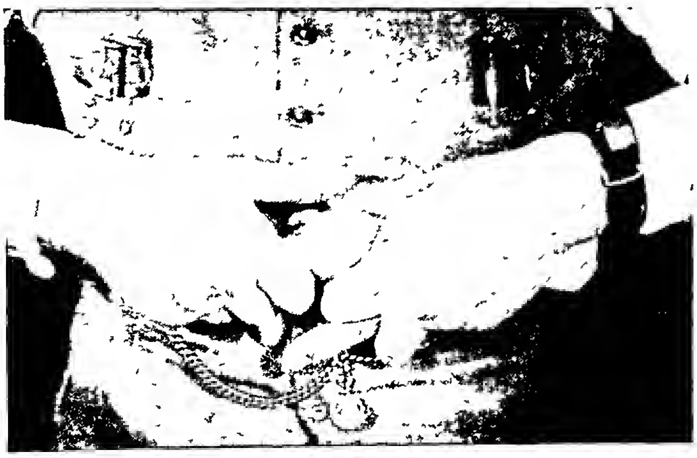

FIG 25 To show how the stabilising hand and that of the patient can be further stabilised by pressing them both against the chest of the manipulator

FIG 27 To show the amount of separation that takes place between phalanx and metacarpal as the result of traction (Contrast with Fig 26)

mobilising hand carries the base of the phalanx forward towards the palmar aspect, it also travels so as to approach the stabilising hand. During the reverse movement it tends to travel slightly away from the stabilising hand. It was not possible to show this clearly in Figs. 28 and 29 owing to the difficulty presented by foreshortening. In actual life the approximation demonstrable is quite clear.

Lateral Flexion

It is necessary to say at once that this movement has nothing whatever to do with adduction or abduction. The idea in mind is to separate the base of the phalanx from the head of the metacarpal, first on one side and then on the other. This is accomplished by pressing the base of the phalanx down on to the metacarpal head on the one side. In order to do this the stabilising hand again assumes a similar grip to that in the former movements, though that of the mobilising hand varies considerably. The thumb and first finger grip the phalanx well towards the base, and in such a position that the tip of each rests slightly proximal to the joint-line on the lateral aspects of the joint. (See Figs. 32 and 33.) Wrist, fingers and elbow of the mobilising hand again become as far as possible a rigid rod and the phalanx is carried over first to one side and then to the other by movements of the shoulder without performing any trace of adduction or abduction at the finger joint. In the figures it will be noted that the tip of the index of the mobilising hand first rests against the radial side of the head of the metacarpal, while the thumb pulls the shaft of the bone over towards the radial side. Then the movement is reversed and the thumb impinges on the ulnar side of the head of the metacarpal, while the first finger pulls the shaft of the bone over towards the ulnar side. The range of movement attainable in full extension or flexion is negligible, and the best result is secured with a slight degree of flexion.

It must be remembered that the objective is to lay strain on the lateral ligaments and that a very considerable amount of leverage is now being employed. Far more care, therefore, must be used in applying the mobilising force than during the previous two movements. The range of movement that can be secured is shown in Figs. 34 and 35 over page.

Rotation

The stabilising hand assumes a grip similar to that taken up during the previous movements, and the joints of the digit that it is desired to move are flexed into the form of a hook. (See Figs. 36, 37, p. 66.) The mobilising hand then grasps this hook, leaving the phalanx which it is desired to move completely free. To treat the metacarpo-phalangeal joint, thumb and first finger grip the lateral sides of the middle phalanx near its base, and both are transverse to the long axis of the bone. It is usually wise to flex the middle finger until the back of the middle phalanx rests more or less transversely across the back of the corresponding phalanx in the patient's digit. Now fingers, wrist, elbow and shoulder of the mobilising hand become rigid,

FIG. 28 To show the antero-posterior movement of the base of the phalanx on the head of the metacarpal, the phalanx being moved towards the dorsal aspect. Note the slight degree of flexion, and that there is no movement of flexion or extension when passing to the position shown in Fig. 29 (*Cf.* Figs 29, 30 and 31)

FIG 30 To show the X-ray appearance of the bones when the finger is held in the position shown in Fig 28

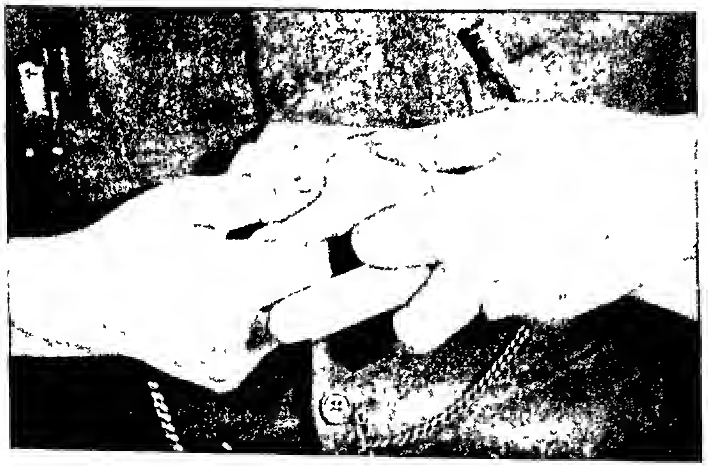

FIG 29 To contrast with the position shown in Fig 28. Here the phalanx is moved towards the palmar aspect

FIG 31 To show the X-ray appearance of the bones when the finger is held in the position shown in Fig 29

and the mobilising force is exerted as the result of pure fore-arm rotation. Therefore the fore-arm must be in the same straight line as the phalanx that is being rotated. The range of movement which can be secured is shown in Figs. 38 and 39, but again a slight degree of flexion is essential for the range of movement to be complete. There is distinct leverage, so the movements must be guarded.

Movements Under Voluntary Control

These are flexion, extension, adduction and abduction. It has already been shown that the physiological movement of flexion consists of movement around a centre which is represented by the metacarpal origin of the lateral ligaments, and that it necessarily follows that, if the base of the phalanx is moved from extension in a forward direction, the phalangeal insertion of the ligament will describe approximately the arc of a circle, and moreover that, if it does not do so, this ligament on both sides will be subjected inevitably to undue strain, if any serious degree of force is used. Therefore, in order to secure flexion the thumb of the stabilising hand is placed on the palmar aspect of the head of the metacarpal, while the thumb of the mobilising hand is placed over the base of the phalanx behind. The fingers of the stabilising hand close naturally round the radial side of the patient's hand, while the fingers of the mobilising hand are so arranged that they rest over the fingers of the stabilising hand. The thumb of the mobilising hand now exerts an impressed force over the base of the phalanx and at right angles to the line of its shaft, and as flexion advances the direction of this impressed force must obviously change so as to remain continuously at right angles to the shaft of the phalanx. (See Figs. 40 and 41, p. 67.) Figs. 42 and 43 show the movement being performed. The mobilising force is impressed mainly by the muscles of the mobilising thumb, and in particular by the flexor of the inter-phalangeal joint of the thumb. Not the least among the many advantages of securing flexion in this manner is that leverage is extremely short, and that the muscles which perform the mobilising movement are comparatively weak. The degree of leverage is therefore relatively very small, and so the utmost impressed force can do no harm. One word of warning, however, is necessary, namely, that the more distally the impressed force is applied over the back of the phalanx, the greater is the leverage, and, therefore, in no circumstances must the mobilising thumb exert pressure over the back of the phalanx except near the base of the bone. It is sometimes asked "What is to happen supposing that the pressure exerted by the mobilising thumb is insufficient to increase the range of movement?" The answer lies in the one word "Stop." If movement cannot be secured as the result of this manœuvre, it is unsafe to secure it at all. The only thing is to wait, and to apply such treatment as is best calculated to lead on towards the alleviation of the inflammatory condition within the joint, to encourage such active movement as may be possible, and to restore vitality to the part by means of heat (preferably by use of the wax bath), by massage and perhaps by electrical treatment in the form of faradic or sinusoidal arm baths. Even

FIG 32 To show the grip for side-bending of the phalanx on the metacarpal It is thus that tension is placed on the lateral ligaments, but, owing to the obvious leverage, it is not without danger This shows radial deviation of the phalanx

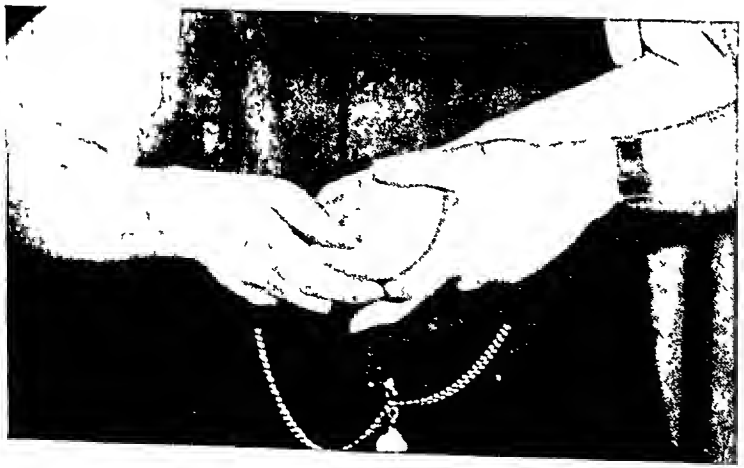

FIG 33 To contrast with Fig 32 This shows ulnar deviation of the phalanx (*Cf* Figs 34 and 35)

FIG 34 To show the X-ray appearance of the relative position of the phalanx and metacarpal when the finger is held in the position shown in Fig 32

FIG 35 To show the X-ray appearance of the relative position of the phalanx and the metacarpal when the finger is held in the position shown in Fig 33 Note the strain laid on the lateral ligament In normal adduction or abduction the base of the phalanx glides over the head of the metacarpal and no alteration of the depth of the joint space is visible on the two sides of the base of the phalanx

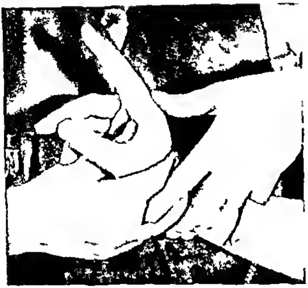

Fig 40 To show the grip for securing forced flexion at the metacarpo phalangeal joint of the index finger To secure extension the position of the thumbs must be reversed

Fig 42 To show the X ray appearance of the bones when the grip is taken as shown in Fig 40

Fig 41 To show how the correct incidence of the mobilising force is maintained against the back of the phalanx by flexion of the inter phalangeal joint of the thumb

Fig 43 To show how flexion of the phalanx takes place automatically when the base of the phalanx is pushed forwards on the metacarpal With the metacarpal origin of the lateral ligament as centre and the phalangeal insertion as radius the base of the phalanx describes an arc of a circle

though no apparent gain may be secured at the time of the manipulation, it frequently follows that the range of voluntary movement is increased, not, of course, to any very great extent at first, but still sufficiently to allow further voluntary increase of movement This is always a tremendous asset and should be encouraged to the uttermost It will then often be found that a second attempt to restore an increased range of movement is more successful ,

FIG 36 To show the grip for securing rotatory movement of the base of the phalanx on the head of the metacarpal This shows movement in one direction, while Fig 37 shows that in the opposite direction

FIG 38 To show the X-ray appearance of the base of the phalanx when rotated as shown in Fig 36

FIG 37. For comparison with Fig 36, to show how the mobilising force for rotating the phalanx on the metacarpal is a plain fore-arm rotation The range of movement is shown in Figs 38 and 39

FIG. 39 To show the X-ray appearance of the base of the phalanx when rotated in the opposite direction to that shown in Fig 38 (*Cf* Fig 37)

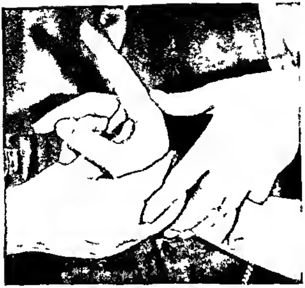

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FIG 44 To show how dangerous forced flexion may be to normal living structures, if flexion is performed at a metacarpo-phalangeal joint without ensuring that the base of the phalanx glides freely round the head of the metacarpal Not only are the lateral and capsular ligaments torn, but even the tendons of the interossei may suffer a similar fate (*Cf* Fig 10, p 52)

and particularly if, in the meantime, all possible movement has been practised daily by a judicious physiotherapist, who will refrain from applying any degree of force which is calculated to cause definite irritation within the joint or in its ligaments.

Let us suppose for a moment that the movement of the base of the phalanx gliding over and around the head of the metacarpal has not been freed, and yet as the result of an external force the phalanx has been bent. A glance at Fig. 44 will show the result. The lateral ligaments and the posterior capsular ligaments are damaged, often beyond repair; and in addition the same fate will sometimes befall the tendons of the interossei. The utter disaster which often followed haphazard manipulation of the joints of the hand under an anæsthetic during the 1914 War will still be fresh in the minds of many of us; indeed, in consequence of these disasters manipulation fell into such disrepute that it was to all intents and purposes abandoned. Later on, definite orders were given prohibiting treatment on these lines. Yet if the technique here described is followed, even if no apparent immediate good comes of it, no harm can possibly ensue, provided, of course, that no active infection is still present within the joint at the time of manipulation. Treatment by manipulation on the lines here mapped out has constantly proved effective, when far more drastic, and presumably less accurate, manipulation has been tried and has failed, even though the patient has persevered faithfully with treatment, despite a large amount of pain and suffering. Unfortunately, if the treatment previously meted out has been too drastic, recovery may have been rendered impossible, not as the result of the original condition for which treatment was prescribed, but as the direct result of the treatment itself.

One word must be said about the forcible extension of these joints, though little will suffice. The stabilising thumb now rests over the back of the head of the metacarpal, the mobilising thumb rests over the front of the base of the phalanx; otherwise the technique corresponds to that for performing flexion. (See Fig. 45.)

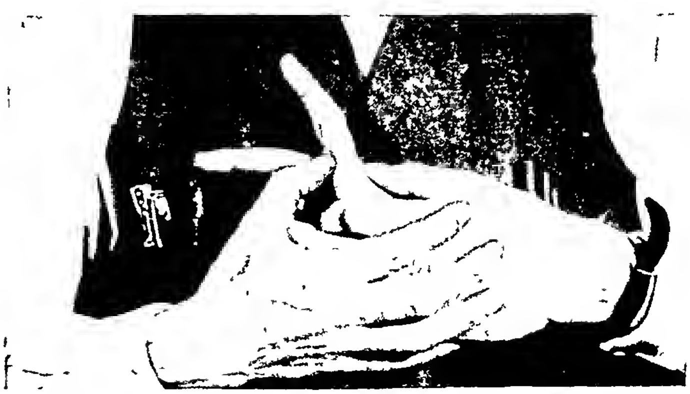


FIG. 45 To show how the positions of the stabilising and mobilising thumbs are reversed when endeavouring to secure extension of the phalanx on the metacarpal.

Finally, with regard to the movements of abduction and adduction: as has already been shown (see Figs. 11-14, p. 53),

these movements are extremely limited in full extension of the metacarpo-phalangeal joints Any movement of this nature which can be made to take place when the fingers are fully extended is mainly due to the movement in the corresponding metacarpal and not to movement at the metacarpo-phalangeal joint As soon, however, as a very slight degree of flexion is allowed the lateral ligaments will allow of a fairly wide degree of movement The thing that we wish to avoid, when trying to perform adduction or abduction, is the movement which has been described above as lateral flexion If we attempt to perform the movements of adduction or abduction, unless the base of the phalanx is free to glide from side to side over the head of the metacarpal, a movement in the nature of lateral flexion will take place

Fig 46 To show how the movements of adduction of the fingers on the metacarpals can be performed *en bloc*

Fig 47 To show the movement of abduction of the fingers for comparison with Fig 46 Note the slight degree of flexion and the relatively small range of movement in this direction

When performing adduction or abduction, the grip taken by the mobilising hand corresponds to that taken during the side-bending movement, but now the tips of the finger and thumb rest distally to the joint which it is intended to move Indeed, it is often wise to perform this movement by moving all the fingers together at the same time, splinting them, as it were, to one another during the movement (See Figs 46 and 47) This movement is comparatively safe It is essential, however, to reiterate one all-important point, namely, that a large degree of the movement which we recognise as full abduction of the fingers in full extension is due to the mobility of the metacarpals on one another, and not to that of the phalanges on the metacarpals

CHAPTER VI

THE METACARPAL JOINTS

Anatomical Considerations

A GREAT deal is spoken about the evils of flat-foot, but comparatively little is ever said of the no less serious condition of the flat hand. As in flat-foot, the disability is due to stiffness, and if the inter-metacarpal joints

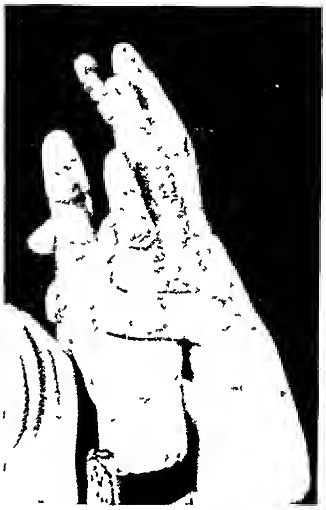


FIG 48 To show the limitation of extension of the fingers if the metacarpal arch is prevented from flattening (*Cf* Fig 49)

FIG 50 To show the limitation of flexion of the fingers when the metacarpal arch remains flattened—the "flat-hand" deformity (*Cf* Fig 51)

FIG 49 To contrast with Fig 48 The result of allowing the metacarpal arch to flatten during voluntary extension of the fingers Note the increase of the range of movement that at once becomes possible

FIG 51 To contrast with Fig 50, to show how the formation of the metacarpal arch is a normal part of the voluntary movement of flexion of the fingers

are not free to move, the result on the functional activities of the fingers is disastrous This can be tested by the simple experiment of clasping the heads of the metacarpals together so as to form an arch and by then attempting to raise the fingers into full extension while maintaining the arch intact The result is shown in Figs 48 and 49 As the arch is allowed to flatten the

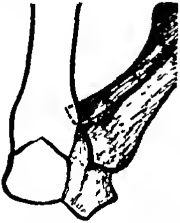


Fig 52 To show the flange like projection on the back of the base of the first meta carpal fitting into a corresponding groove on the back of the trapezium It is plain that this must tend to steer the movement of the meta carpal

Fig 53 Lateral view of the base of the first metacarpal showing the saucer like depression which fits on to the convex surface of the trapezium

increase in the range of extension of the fingers at once becomes apparent On the other hand, if the heads of the metacarpals are held so as to prevent the formation of the metacarpal arch, the range of flexion of the fingers is markedly lessened (See Figs 50 and 51)

We see at once, therefore, the immense importance of the joints on the sides of, and at the bases of, the metacarpals The former are often held to be of small account, possibly owing to the diminutive size of many of them Yet for the functional integrity of the hand they are of equal importance to that of the larger joints at the proximal ends of the bones, or presumably they would not be there to function There is no joint between the adjacent sides of the first and second The joints at the bases articulate with the corresponding bone or bones of the carpus The most superficial study of these joints shows at once the very complicated nature of the mechanism of their movement To begin with, when we view the first metacarpal either from dorsal or palmar aspect, we can note that there is an angular process or flange which dips down, as it were, into a groove on the trapezium into which each fits as into a socket This groove must obviously tend to stability, preventing the base of the metacarpal from slipping laterally inwards or outwards (See Fig 52) Moreover, it must serve to

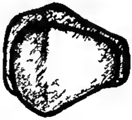


Fig 54 The joint surface on the base of the first metacarpal showing the ridge that divides it into two parts—the larger being the outer

direct the movement of the shaft of the metacarpal and tend to prevent deviation to right or left. Seen from the side the base of the phalanx is hollowed antero-posteriorly so as to form a mortise into which the trapezium fits snugly. (See Fig. 53.) Finally, running antero-posteriorly across the base is an elevation which joins the two flanges already mentioned in front

FIG 55 To show how the base of the second metacarpal fits by a V-shaped arch on to the distal surface of the trapezoid

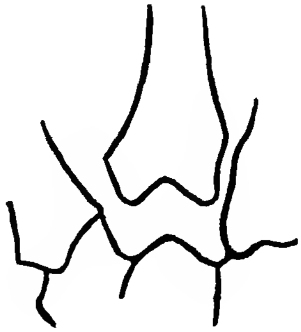


FIG 56 To show diagrammatically how the base of the second metacarpal is wedged between the trapezium and the base of the third metacarpal It is here shown pulled away from its mooring Note how the trapezoid projects into the base of the metacarpal

and behind. This ridge divides the joint surface into two unequal parts, the larger being to the outer side. (See Fig. 54.) Here, then, we have further provision for steering the base of the metacarpal, for providing for stability, and for a wider range of abduction than adduction, though both are limited by the bony conformation.

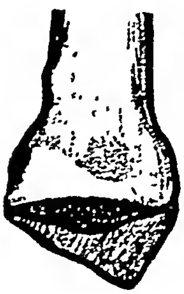


FIG 57 To show the articular facet on the inner side of the base of the second metacarpal It also shows the ridge dividing the joint surface into two and the styloid-like process in which this dividing ridge ends

When we pass to the case of the second, we find a somewhat similar but exactly reversed condition; there is a prominence on the distal end of the trapezoid which runs upwards in a sort of point into the middle of the base of the second metacarpal. (See Fig. 55.) This, again, must tend to guide the movement of the bone in an antero-posterior direction, but at the same time we must recollect that the outer side of the bone articulates with the side of the trapezium, while the inner side articulates with the base of the third metacarpal—both over a relatively wide area. (See Fig. 56.) There can be no doubt that there is a definite degree of movement antero-posteriorly of the metacarpal on the trapezoid, and of the second metacarpal upon the radial side of the third, as here there is a definite facet. This facet on the third metacarpal is a continuous surface with a ridge dividing it more or less into two parts. (See Fig. 57.) This ridge must tend to restrict the movement of the second metacarpal on the third, when the former moves antero-

posteriorly on the trapezoid From a general comparison of the size and shape of the joint surface between the metacarpal and the trapezoid we should expect to find a relatively wide range of movement in an antero-posterior direction, and yet the ridge on the joint surface between the second and the third metacarpals indicates a check to this movement If the two metacarpals move in unison, this is of no importance, but it is easy to see how this ridge might pass out of alignment with the corresponding hollow on the side of the third metacarpal, if the latter fails to move in unison Indeed, it is probably due to this that derangement at the base of the second metacarpal is more common than at the bases of the other metacarpals

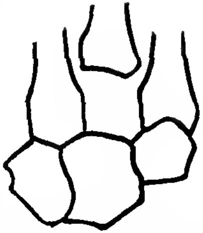


FIG 58 To show the space into which the base of the third metacarpal is wedged Note the obliquity of the set of the articular surface on the os magnum

At the base of the third metacarpal we find the styloid process dipping down into contact with the trapezoid, and then the rest of the base of the bone rests upon the distal end of the os magnum The plane at which this joint is set is slightly oblique from behind forwards and inwards, and obviously must guide the movement of the metacarpal with a slight tendency, when moving forward, to lean towards the radial side (See Fig 58) The joint between the fourth metacarpal and the third is quite unlike that between the second and the third, instead of a mere groove on a single surface, the surface of the articulation is now divided into two These surfaces are relatively very small and yet their presence points to the existence of definite, though limited, movement between the two bones (See Fig 59) The base of the bone is hollow from before backwards, and the styloid process forms a sort of buttress which must materially serve to prevent hyper-extension Also the joint surface which fits on to the os magnum is wider behind than in front (see Fig 60), thus forming a blunt wedge with the apex directed forward This leaves the articular facets on the sides of the base of the third metacarpal, which articulate with the second and fourth, set on an oblique plane, so that they tend to approach one another in front on the palmar aspect Not only is stability thus ensured so far as the base of the third metacarpal is concerned, but

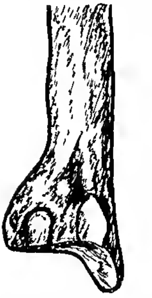


FIG 59 To show the division of the articulation on the side of the third metacarpal between it and the base of the fourth metacarpal A strong interosseous ligament divides them and so the range of movement must be restricted far more than if the articular surface were continuous

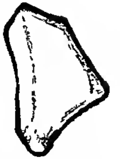


FIG 60 The base of the third metacarpal showing how the joint surface for articulation with the os magnum is wedge-shaped the base of the wedge being towards the dorsum

FIG 61 To show the single facet at the base of the fifth metacarpal that articulates with the fourth

this base serves also as a keystone of the arch of the metacarpal bases, and around it the fourth and fifth swing on the inner side, and the second on the outer side. This is in contrast with the corresponding arrangement of the foot, where the second metatarsal is the pivot around which the outer metatarsals revolve. (See Fig. 211, p. 157.)

At the base of the fourth metacarpal the story is more or less reversed ; there are of necessity the two joint surfaces on the outer side of the bone to correspond with those on the base of the third ; while, on the inner side, the joint which unites the base of the fourth to the base of the fifth metacarpal is a single smooth surface without any vestige of division or any trace of a ridge. (See Fig. 61.) The base of the fourth fits into a space formed by four bones—two metacarpal and two carpal bones—with something of a convexity when seen from behind. Thus is formed a buttress, as it were, to the base of the bone where it rests between the os magnum and the unciform. (See Fig. 62.) It is reminiscent of the convexity of the base of the first. This formation must again lead to stability, but the formation of the joint between the second metacarpal and the carpus and between the fourth metacarpal and the carpus has this striking differentiation. The base of the fourth more resembles the base of the first in that it is furnished with a prolongation backwards towards the middle of the bone, though considerably more blunt than in the case of the first. At the base of the second, however, the convexity is on the carpal side of the joint instead of on the metacarpal side. (See Fig. 56, p. 72.)

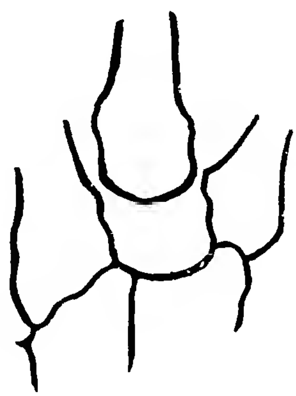


FIG 62 To show how the base of the fourth metacarpal is wedged between four bones—two metacarpal and two carpal bones The antero-posterior ridge across the base divides the surface into a larger surface (for the unciform) and a smaller (for the os magnum) Thus the larger part of the facet is on the inner side on the base of the first metacarpal the larger was seen to be on the outer side (See Fig. 54, p 71)

Of the joints of the base of the fifth metacarpal little more remains to be said : the surface at the base is more saddle-shaped than those already considered and articulates with the unciform. The relative simplicity of the joints at the base of this bone can only tend to increase of mobility. Indeed, this short survey should show that, as we approach the inner part of the metacarpus, the mobility increases steadily from the third to the fifth in so far as the movement of the base of one metacarpal around the base of its fellow is concerned. With regard to antero-posterior movement the third is by far the most stable, the fifth by far the most mobile, but the second is the most vulnerable.

We must now consider the amazing problem of the why and wherefore of this extraordinarily complicated mechanism. The first obvious point is that the main joint-line between the carpus and the metacarpus is built for stability. Had this joint-line been relatively

straight there can be little doubt that stability would to that extent have been sacrificed The main point which the study of these joints as a whole impresses most strongly is that the arrangement is for an antero-posterior movement not only of the bases of the metacarpals on the carpus but also of the metacarpals on one another The arrangement of the joints between the metacarpals, however, effectively prevents true antero-posterior movement between the bones, but rather impresses upon them a movement which tends to swing the one bone round upon that next adjacent to it The movement of lateralisation is sacrificed almost entirely to stability, and indeed the amount of this movement in the metacarpus as a whole is very small (See Figs 63 and 64)

FIG 63 X ray photograph to show the relative position of the bones when the metacarpus as a whole is moved into radial abduction (*Cf* Fig 64)

FIG 64 To contrast with Fig 63 to show the range of movement when the metacarpus as a whole is moved from radial abduction to ulnar adduction

As we have seen of all the bones of the metacarpus the base of the medius is the most stable while the base of the fifth undoubtedly is endowed with the widest range of movement These anatomical facts have a serious bearing on the technique of manipulation of the joints at the bases of the metacarpals, and an accurate knowledge of them, as well as of the physiological movement which takes place in the joints, is essential if manipulation is to be scientifically correct One lesson at least is very early learned and will serve as an illustration If the head of the fourth metacarpal is gripped by the stabilising hand so as to prevent all movement, and if the shaft of the fifth is grasped near the head of the bone and an attempt is made to move it in a plain antero-posterior direction, the range of movement will be found to be very small If, however, during the movement the bone is allowed to follow the physiological course, which is that of an arc around the base of

the fourth, an increase of the range of movement amounting to almost 50 per cent will be found to be practicable. Here, then, is the key to the rules which should govern the manipulation of the joints at the bases of the metacarpals—follow the physiological course.

Movements Not Under Voluntary Control

Traction

Of these movements, the first, and perhaps the most important, is, as usual, traction. It is true that it is practically impossible to obtain a secure grip on the distal end of any of the metacarpals, and, therefore, traction can only be applied indirectly. There can be no question at all that traction applied to the proximal phalanx in a direction parallel to the long axis of the shaft of the metacarpal must transmit a portion of the force to the base of the metacarpal. It sometimes happens that the base of the second metacarpal slips backwards on the carpus and remains locked in this position, giving rise to a most disabling and painful condition. In order to remedy this the traction is applied to the finger with the "golf-club" grip as already described (see Fig. 24, p. 60), but with one difference. When merely applying traction to the metacarpo-phalangeal joint the thumb takes no part in the movement, but now the thumb is of very definite service, as it should rest on the back of the middle of the metacarpal and should lie directly parallel to it. (See Fig. 65.) The thumb of the stabilising hand, too, requires an alteration of grip; this should be placed directly over the base of the second metacarpal so as to be able, when the traction is applied, to press the base of the metacarpal directly forwards, acting in unison with the thumb of the mobilising hand. A study of the shape of the articular facet on the base of the bone probably gives the explanation of the fact that this bone, above all the other metacarpals, tends to lock. There is a transverse ridge straight across the basal articular facet which obviously must fit into a corresponding hollow on the trapezoid. If an impressed force has caused this ridge on the base of the bone to slip beyond a certain limit it must of necessity impinge upon a portion of the trapezoid which is not intended to receive it, and so the base of the bone is, as it were, levered away from the carpus, and the ligaments will of necessity become taut. If the force is sufficient this will cause a binding or "seizing-up" of the two joint surfaces on onc [illegible]. The bases of the other metacarpals—except perhaps

FIG 65 To show how the "golf-club" grip already illustrated in Fig 24, p 60, should be adapted to lay traction on the base of the metacarpal The thumb is now of material service, as the two thumbs acting in unison on the back of the base of the metacarpal can impress a considerable mobilising force towards the palmar aspect while traction is applied

the first—do not seem to catch in a similar manner Should they do so a corresponding technique should be employed

Beyond a definite degree of lateralisation that is possible when moving the whole of the metacarpus *en masse* (see Figs 63 and 64 p 75), there are, strictly speaking no other movements which it is possible to perform which are not under voluntary control Yet this is not the whole truth, for, during the course of manipulation of the joints one metacarpal only can be moved upon its fellow, and, as a necessary corollary on the distal surface of the corresponding bone (or bones) of the carpus Voluntarily this is a complete impossibility, since no one is capable of performing movement at the base

Fig 66 Grip for mobilising the joints at the base of the fifth metacarpal the fourth being stabilised (*Cf* Fig 67)

of one of the metacarpals except as part of a co-ordinated movement involving most, if not all, the others This, of course does not apply to the thumb

Two methods of loosening the joints at the bases of the metacarpals are available In the first the grip, taken by the stabilising hand to perform the movements which are possible at each metacarpal in turn, is secured by gripping the shaft of the metacarpal we wish to stabilise between the fingers and thumb, the grip being taken as near the head of the bone as is possible The thumb and first finger of the mobilising hand then grip the shaft of the metacarpal which it is desired to move, with both transverse to the shaft of the bone (See Figs 66 and 67) The tips of the forefingers rest on the palmar aspect in the same straight line as one another, and are so placed as nearly to touch one another, the tips of the thumbs occupy a

corresponding position on the dorsum. Having secured absolute fixation of the stabilising hand, the mobilising force is impressed from the shoulder muscles ; fingers, wrist and elbow of the mobilising hand remaining absolutely rigid. The grip taken and the force impressed should aim, first of all, at carrying the head of the metacarpal backwards and then pressing it directly towards the metacarpal that is being stabilised ; then the force should strive, as it were, to draw the metacarpal head away from its fellow and to carry it forward around the latter in the arc of a circle. The head of the bone, having been carried as far forward as is possible, is then impressed towards that of its fellow so as to try to obtain as much circular movement

FIG 67 To show how the full range of movement starting from the position shown in Fig 66 is secured by a mobilising force mainly impressed by the shoulder muscles This illustrates the movement of one metacarpal on the adjacent one which is stabilised

of the one bone round the other as is physiologically practicable. In this way the fifth is moved upon the fourth, the fourth is moved upon the third, and the second is moved upon the third. It will be found extremely difficult to move the third upon the fourth or upon the second.

The second method of loosening the joints at the bases of the metacarpals--and it is usually wise to apply both—is somewhat more complicated, and the movement consists of mobilising the two adjacent bones at the same time. With this in view the tip of the index finger of the mobilising hand is placed on the palmar aspect of the neck of one metacarpal while the thumb is placed over the dorsal aspect of the neck of its fellow. (See Figs. 68 and 69.) Finger and thumb must lie directly transverse to the shafts of the two bones. The stabilising hand merely fixes the rest of the limb so as to

allow as little shaking as possible while the mobilising force is exerted Now, while the tip of the index finger presses up the head of the one metacarpal towards the dorsum, the thumb presses the other one down towards the palm then the movement is reversed, the thumb presses down the back of the first metacarpal under consideration while the index finger presses the other backwards towards the dorsum As far as possible the impressed force is conveyed from the shoulder muscles, fingers and wrist of the mobilising hand should be held completely rigid, and, although the elbow flexes and extends to a very slight extent, these movements should be extremely limited, and fore-arm rotation should be completely absent

Fig 68 To show the alternative method of mobilising the joints at the bases of the two adjacent metacarpals This shows the limit of movement in one direction (*Cf* Fig 69)

Fig 69 To show the limit of movement in the reverse direction to that shown in Fig 68 The difference in the view seen of the mobilising fore arm is not due to fore arm rotation It is merely the change of view necessitated by dropping of the shoulder from a wide degree of abduction into full adduction

Movements under Voluntary Control

The Movements of the Metacarpal Arch

These consist of flattening and re-forming the metacarpal arch *in toto*, and, to complete the manipulation, it is always wise to make sure that the flattening of the metacarpal arch as a whole is complete, and this should be followed by the full bowing of the arch In order to secure the flattening, both thumbs and both index fingers are placed transversally across the hand, the forefingers in front, the thumbs behind (See Fig 70) The forefingers touch one another so as to form a continuous straight line, and the thumbs are slightly separated and should rest one on each side of the middle metacarpal The mobilising force is now impressed by dorsi-flexing both wrists, all other joints should remain completely rigid In order to restore the full formation of the bow of the metacarpal arch, the thumb of the stabilising hand is placed over the palmar aspect of the head of the middle metacarpal (See Fig 71) The thumb of the mobilising hand rests on the inner side of the fifth metacarpal near the head, and the index finger rests in a corresponding position on the outer side of the second metacarpal The mobilising force to re-form the arch is applied by

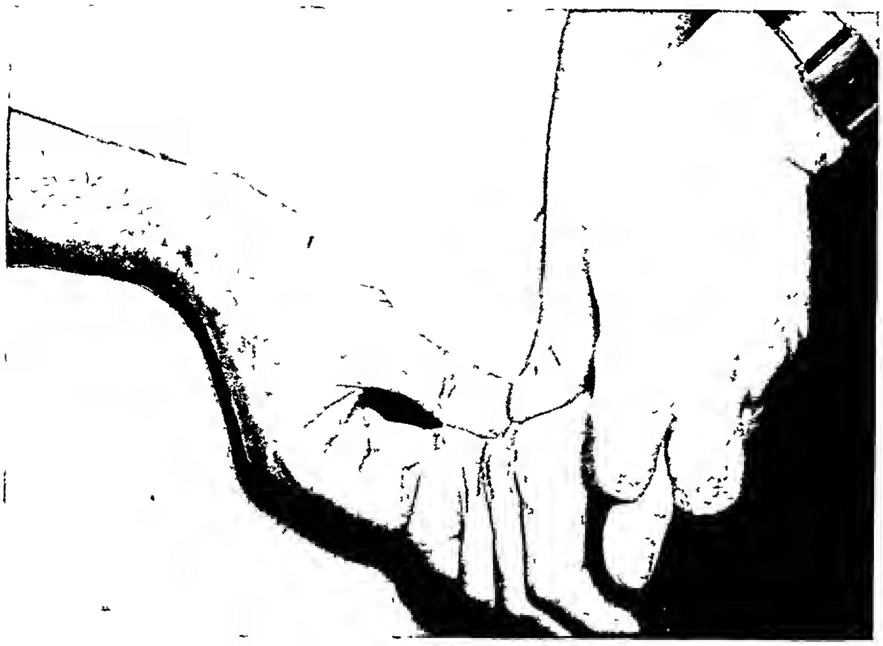


FIG 70 To show the grip for flattening the metacarpal arch before the wrists are dorsi-flexed

approximating the thumb and the index finger towards one another over the dorsum of the hand, while pressing forwards so as to areh the metacarpal heads over the stabilising thumb whieh rests on the palmar aspect.

The Movements of the First Metacarpal

A few words must now be devoted to the speeial necessities of the joint at the base of the first metacarpal. We have seen this is a saddle-shaped articulation when viewed from the lateral aspect, and there is a marked concavity as we pass from the anterior to the posterior aspeet of the joint. (See Figs. 52-54, p. 71.) But we must also remember the elevation, that almost amounts to a ridge, dividing the articular surface into two slightly unequal halves. Provided that the ridge on the base of the metacarpal fits accurately into the corresponding concavity of the trapezium during movement, all is well. We also saw how the danger of undue range of forward or backward movement of the base of the bone on the carpus is minimised. There is no sueh proteetion, however, on the lateral movement ; and, if any foree is impressed in sueh a manner as to eompel an undue degree of lateral movement to the ridge whieh runs antero-posteriorly aeross the joint surface, this ridge may be eaused to impinge upon a part of the joint surface of the trapezium into whieh it does not fit with aeeuraey. The shaft may also be rotated, as we shall see later. The ligaments

FIG 71. To show the grip for re-forming the metacarpal arch after it has been flattened as shown in Fig 70

will then become taut, and, if the force is sufficient, they will become so taut that the two joint surfaces will be drawn so tightly together that they will "seize-up" or "bind" upon one another. Traction with the "golf-club" grip is often all that is required to remedy this condition. How it works is a little difficult to state with certainty, though the explanation offered by Marlin is the most probable. He speaks of the "springing" of the joints, and suggests that at least one type of disordered function within a joint such as this may be due to some mild degree of rotation of the shaft of the metacarpal. This, of course, rotates the base of the bone, and the accurate fit of the two joint surfaces on to one another is lost: hence the sensation of weakness or of pain, or perhaps of both. With the application of traction the two joint surfaces are dragged away from one another, and then are allowed to spring together again owing to the elastic recoil of the lateral ligaments. As there is now no impressed force acting which will cause undue rotation of the metacarpal on the carpus, the two bones naturally drop together into the exact position which it was intended by Nature that they should occupy, and the torsion, or perhaps the slight lateral displacement, can thus be made to disappear. It commonly happens that movement in only one direction is painful, and the grip of the mobilising hand should then be altered slightly, as it is probable that the thumb will be required to play an active part. The traction is applied with the "golf-club" grip as usual, but the palmar surface of both thumbs should rest on the side of the metacarpal, so that by exerting a slight thrust on the base of the bone we can, without relaxing the traction, increase the movement which has been found to be painful. (See Fig. 72.)

FIG. 72. To show how the thumbs may be employed to impress a mobilising force while traction is being applied to the first carpo-metacarpal joint.

Apparently very trifling so-called "sprains" of the thumb can be entirely disabling, as often enough even the amount of pressure necessary to hold a pen will transmit to the joint a force sufficient to cause such pain as to render continuation of the movement impossible, while more vigorous movements are quite out of the question.

It may be said that the explanation given above is all a matter of speculation, and that, if it were correct, X-ray evidence would prove the existence of the type of injury thus described. We must, however, remember that, when a ridge on one bone fits into a concavity on another bone, the fit is accurate, and a rotation of the ridge of the one bone through a very minute angle will throw the joint surfaces out of truth, and the disability that will thus be caused in any working joint is quite obvious, while the degree of lack of truth in the alignment of joint surfaces may be so small that no X-ray photograph could be expected to reveal it.

Movements of the Sesamoids

Occasionally disability may be due to the formation of adhesions in the joints found in the neighbourhood of sesamoid bones. If pain is caused by impressing a mobilising force directly on the bone with the forefinger, it is always worth while to free its mobility by direct pressure upon it. The first movement should be distally, pressing it in the direct line of the tendon towards its insertion. Then the bone should be moved laterally in both directions, the impressed force acting at right angles to the tendon. Finally, the bone should be moved proximally, again in the same straight line as the tendon, towards the origin of the muscle.

CHAPTER VII

THE WRIST REGION

Anatomical Considerations

HERE again we have to consider carefully the anatomical outlines of the joints in order to secure reliable guidance towards true scientific accuracy in our practice of manipulation As has already been pointed out, although it is common to speak of dorsi-flexion and palmar flexion of the wrist, these terms lack scientific correctness, as a very simple investigation will show

FIG 73 X ray photograph of the carpal joints taken when the hand is in full radial side flexion (Cf Fig 74)

FIG 74 X ray photograph of the hand in ulnar side flexion for comparison with Fig 73 It is perfectly plain that the lateral movements of the hand hardly affect the relative positions of the carpal bones at all but that they take place mainly at the radio menisco carpal joint or true wrist joint The movement of the os magnum on the semilunar though quite definite is negligible compared with that of the scaphoid on the radius

It was noted in Chapter I (see Figs 1-3, p 12) that, if the hand is held beneath a fluorescent screen, the movements of dorsi-flexion and palmar flexion of the hand are shown to be not by any means solely the function of the true wrist joint, but that, as the hand travels backwards into dorsi-flexion from the mid-position, by far the greater part of the range of movement is seen to take place at the mid-carpal joint, while in palmar flexion from the mid-position movement takes place mainly at the radio-menisco-carpal joint, or true wrist joint If the hand is then placed in such a position as to secure

an antero-posterior view, it will be found that radial and ulnar deviation of the hand are performed almost entirely in the true wrist joint. (See Figs. 73 and 74.) The facts underlying these simple observations must, of course, profoundly affect the technique of manipulation. In Fig. 75 we have a sketch of the contour of the true wrist joint and of the transverse inter-carpal joint. We are at once struck by the contrast between the smooth circular appearance of the contour of the proximal aspect of the carpus and the straggling and irregular line formed by the transverse inter-carpal joint. On the proximal side of the wrist joint we find that the lower end of the radius is provided with an antero-posterior ridge dividing the articular facet into two not quite equal parts, the outer for articulation with the scaphoid, the inner for articulation with the semilunar. (See Fig. 76.) Then of necessity there is a dip on the surface of the joint where the meniscus, which rests between the head of the ulna and the carpus, is attached to the lower end of the radius, and finally we come to the area where the distal surface of the meniscus articulates with part of the semilunar and part of the cuneiform.

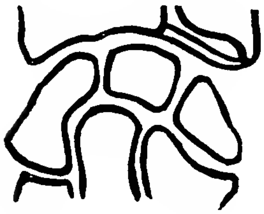


FIG 75 Outline drawing to show the contours of the joint surfaces between the carpus and the forearm bones at the true wrist joint and at the transverse inter-carpal joint (*Cf* Figs 73 and 74 overleaf)

The radial styloid projects downwards as a strong boss of bone on the outer side of the carpus, while the inner side has no similar bony protection. The styloid of the ulna is too small to provide a buttress of any sort, and is, moreover, too far removed from the carpus, to be of any real use for protective purposes. (See Fig. 73.)

We now see how it comes about that, starting from the mid-position, radial abduction of the hand from the mid-position can only pass through a few degrees while ulnar adduction can pass through a very much greater range. Approximate measurement indicates that whereas radial abduction can take place through only some 20 degrees, the range of ulnar adduction is as much perhaps as 45 degrees. (See Figs. 73 and 74, p. 83.) The antero-posterior ridge on the radius, which, in the mid-position, rests upon the ligaments between the scaphoid and the semilunar, must of necessity tend to change in relationship to the carpus when lateral deviation of the hand occurs. As has already been explained, ridges of this type on a joint surface are always a potential source of danger; since, where a bony convexity fits exactly into a bony concavity, a very slight degree of abnormal movement will disturb the exactness of the "fit," and cause the bony convexity, instead of resting in the concavity, to press against the convexity which flanks the concavity, with the result that two convex surfaces press upon one another with a force which was not intended by Nature. This means that the joint

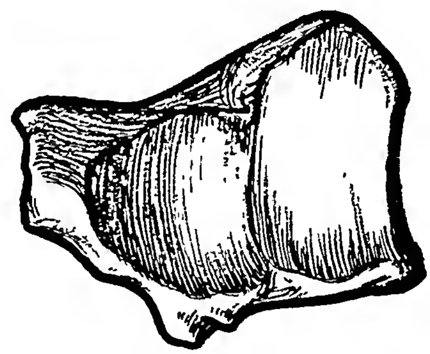


FIG 76 View of the articular facet on the distal end of the radius showing the ridge dividing the surface into two unequal parts The ridge fits into the groove formed between the proximal surfaces of scaphoid and semilunar

surfaces, normally in contact, are separated from one another, and a tightening of the ligaments which hold the bones together necessarily follows Any impressed force which tends to produce further movement will cause the

Fig 77 To show the rotation of the hand upon the fore arm at the true wrist joint This view shows the degree of supination (See Figs 78 and 79)

Fig 78 To contrast with Fig 77 to show the range of movement of the hand from supination into pronation that is possible at the true wrist joint Note the stabilising hand has not moved from the position taken up in Fig 77 and so no fore arm rotation took place

Fig 79 To show the extent of true rotation of the carpus that can take place on the fore arm without rotation of the fore arm bones This shows the full degree of supination

Fig 80 To compare with Fig 79 to show the extent of pronation that is possible (Cf Figs 78 and 79)

ligaments to tighten yet more, and thus to drag the two convex surfaces still more firmly together, and sooner or later they must "seize up" or bind upon one another Rotatory or torsion strains are the most liable to cause injury of this nature

It is true that the transverse ridge on the lower end of the radius is so slight, and the elasticity of the ligaments so great, that the danger of binding from this particular cause is comparatively small. We must remember, however, that at the true wrist joint there is a marked degree of rotatory movement, provided, no doubt, so that the spring of the ligaments may act as a buffer against detrimental impressed forces. It is not of sufficient range to be of any functional utility (see Figs. 77 to 80), yet it is quite enough to allow a definite alteration of the alignment of the radial ridge on the corresponding surfaces of the carpus. Such alteration must tend to produce within the joint a sensation of abnormal movement, which in turn must disturb the joint-sense on which the co-ordinated movements of the muscles depend. Thus a very trifling deviation from the normal may lead to a sensation of weakness. The same reasoning, of course, applies to the ridge on the carpus which fits into the dip provided by the inner limit of the radial articular surface and the surface of the meniscus.

A further consideration of the lower end of the radius will show that the posterior aspect of the joint surface projects somewhat further downwards towards the hand than the anterior. This accounts for the fact that dorsi-flexion of the hand, so far as the proximal row of carpal bones is concerned, is more limited than palmar flexion. This, again, entails the necessity for further provision for full dorsi-flexion, and the transverse inter-carpal joint supplies the need.

When we come to the consideration of the contour of the transverse inter-carpal joint itself, we cannot fail to be impressed with the wonderful nature of its structure, but we must not let this prevent us from gleaning from inspection all the information we can. A glance is sufficient to show one thing, namely, that whereas, seen from the antero-posterior point of view, the line of the true wrist joint follows a continuous arc which thus allows great freedom of movement, the corresponding line between the two rows of carpal bones is so irregular that it is inconceivable that any radial or ulnar deviation between the two rows can possibly take place. (See Fig. 75, p. 84.)

The next point for consideration is the articular surface on the head of the os magnum. (See Fig. 81.) On the anterior aspect of the surface it is sharply limited; on the posterior aspect it extends backwards over a very long surface. It will be seen at once that the head of the bone is, as it were, wedged in by a V-shaped prominence between the articular surface of the scaphoid and the semilunar, so as to ensure a degree of stability which can only be disturbed with very great difficulty. Yet the shape of the distal articular facets on scaphoid and semilunar is such as to allow a relatively enormous range of movement of the head of the os magnum on these bones during the movement of dorsi-flexion of the hand. The remainder of the transverse carpal joint, in both the outward and the inward direction, has obviously been designed by Nature to share in, and so to re-inforce, support of the os magnum during movement. This, then, may be considered as the keystone of the arch in which, during dorsi-flexion, the distal row of carpal bones moves upon the proximal; while on the lateral aspects there is a degree

of fixed stability (granted the buffer action of the ligaments) which could not otherwise be attained

Perhaps the most astonishing fact about the joints in this region is that, while the contour of the transverse carpal joint, when viewed in the antero-posterior direction, presents a most tortuous and sinuous line (see Figs 4, p 13 and 84, p 89), yet, when viewed from the distal aspect the surface from behind forwards is entirely smooth and regular (See Fig 82) This perfect freedom of movement is provided in this one direction and almost complete stability in the lateral direction (Contrast the movement shown in Figs 1, 2 and 3 p 12, with that shown in Figs 73 and 74, p 83)

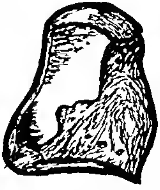


Fig 81 To show how the proximal articulation on the head of the os magnum extends further on to the posterior aspect of the bone than on to the anterior Fig 73 shows how the bone is wedged in between scaphoid and semilunar (See p 84)

Still, we must bear in mind that the ligaments between carpal bones of the same row provide the buffer action to which reference has been made, and the presence of articular facets on the lateral aspects of the carpal bones also indicates that in the same row these bones are intended to move one upon the other The range of movement is, however, very slight as is shown by the comparatively small area of the facets When we consider the semilunar facet on the scaphoid which articulates with the semilunar bone, we cannot doubt that Nature intends definite movement to take place between them, and on the opposite side of the semilunar there is a very definite circular facet for articulation with the cuneiform Here, then, we have further provision for normal movement, and similar conditions are found on adjacent surfaces in the distal row of carpal bones Still, when all is said, the articular facets between individual pairs of carpal bones occupy only a small area as compared with that of the facets between the two rows, or between the carpus and the lower end of the radius

Fig 82 View of the distal articular surfaces of the proximal row of carpal bones to show how impossible must be lateral movement of the distal row of carpal bones upon it and yet how free is the antero posterior movement

It would appear, therefore, from a study of the joints between the individual carpal bones of the same row that, while provision is made for movement, it is only for a very small range of movement, insufficient to be of practical use in the ordinary motions of the hand The buffer or buttress action would therefore seem to be the main function of these joints If in place of either row of carpal bones there were a single bone shaped to coincide exactly with the contour of the two rows respectively the strain and stress which would fall upon such single bones would undoubtedly be too great for safety

When we consider the impressed forces which must at times reach these joints with relatively great leverage, it is not surprising that one bone or another should sometimes be compelled to a movement beyond the safe

physiological limit. The joints are not shaped for torsion one upon another in the same row ; and, should this action occur from any cause, the interosseous ligaments must tighten, thus drawing the adjacent surfaces closely together. If the torsion is considerable, this can only result in the two surfaces binding on one another.

Though no rotation of the distal row of carpal bones upon the proximal can be perceived, and though there is no trace of any lateral mobility between the two rows, yet there can be no doubt that an external force is capable of causing, to some extent, abnormal movements of individual carpal bones. When we remember the extreme irregularity of the outline of the transverse inter-carpal joint, it is only to be expected that, with the many strains and stresses to which the joint is subjected—and such as are encountered in the ordinary actions of life—a slight slip should occasionally occur sufficient to cause some two adjacent surfaces to bind upon one another. The ligaments between the bones of each row allow a certain amount of movement between each pair of bones, and again it is not surprising that an abnormal impressed force should sometimes cause one bone to rotate upon its fellow beyond the limit of physiological movement, and so should cause binding to take place. It is well known that an impressed force, if sufficiently vigorous, may cause the semilunar to become dislocated forwards between the scaphoid and the cuneiform—a gross and demonstrable injury. It is only reasonable to assume that a lesser force may produce a lesser displacement, which, even if very slight, may result in derangement of function. The same applies to all the joints of the carpus.

Movements Not Under Voluntary Control

1. Movements of the Inter-carpal and Radio-carpal Joints

Traction

The chief of these is traction. We have spoken of the interosseous ligaments acting as the springs of a buffer. Figs. 83 to 86, showing the result of traction and pressure upon the joints of the carpal region, demonstrate how far this is justified.

In order to apply traction as a mobilising force, when the patient is upright, the arm is allowed to hang by the side with elbow bent to a right angle. The stabilising hand is then placed with its palmar surface over the lower end of the humerus, thumb and first finger pointing downwards ; the wrist is fully dorsi-flexed and the elbow fully extended so that the whole of the manipulator's arm and fore-arm rest as nearly as possible at right angles to the lower end of the humerus. (See Fig. 87, p. 90.) The mobilising hand places the patient's fore-arm in the mid-position of rotation and then grasps the prominences formed by the carpal bones on either side, the thumb resting just proximal to the radial prominence, the first finger in a corresponding position above the ulnar prominence, and both directly transverse to the patient's fore-arm. The other fingers close gently over the palmar aspect of the patient's hand. The fingers, wrist and elbow of the mobilising hand are fixed as rigidly as may be ; the mobilising force is exerted by abduction of the operator's shoulder joint,

and, better still, if assisted by trunk rotation The force must be exerted directly parallel to the long axis of the fore-arm of the patient, and it is necessary therefore that the patient's hand should be dropped somewhat into ulnar deviation and slight palmar flexion before the force is applied It can be seen from Figs 83 84 and 86 that as the result of traction, not only is the distal row of carpal bones pulled away from the proximal and the proximal row from the radius, but it will be noticed that the curve of the proximal row of carpal bones is slightly accentuated so as to form, as it were, an arc of lessened diameter It is also seen in Figs 83, 85 and 86 that pressure in the opposite direction, *i e* of the hand directly upwards towards the fore-arm,

FIG 83 To show the relative positions of the bones of the carpus before traction is applied (*Cf* Figs 84 and 85)

FIG 84 To show the marked alteration of the relative positions of the bones in the carpal region when traction is applied (*Cf* Figs 83 and 85)

FIG 85 To show the effect of direct upward pressure of the hand against the radius and meniscus Compare with Fig 84 and note the splaying out of the arch of the proximal row of carpal bones (This is best shown in the superimposed tracings of Figs 84 and 85 See Fig 86)

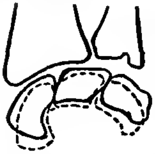


FIG 86 Superimposed tracings of Figs 84 and 85 to show the splaying out of the arch of the proximal row of carpal bones when pressure is applied to the hand (firm line) compared with the position when traction is applied (dotted line)

causes a corresponding yielding, so that the diameter of the arc would be increased to a corresponding extent

We can now see how the application of traction, by separating the two rows of carpal bones from one another, and by altering the relative positions of the individual bones, naturally tends to a general re-adjustment, and when the traction is relaxed the bones spring back, as it were—they may even snap back—into normal position and relationship, owing to the elastic recoil of the stretched ligaments thus this very simple manœuvre can frequently bring instantaneous relief to comparatively severe disability

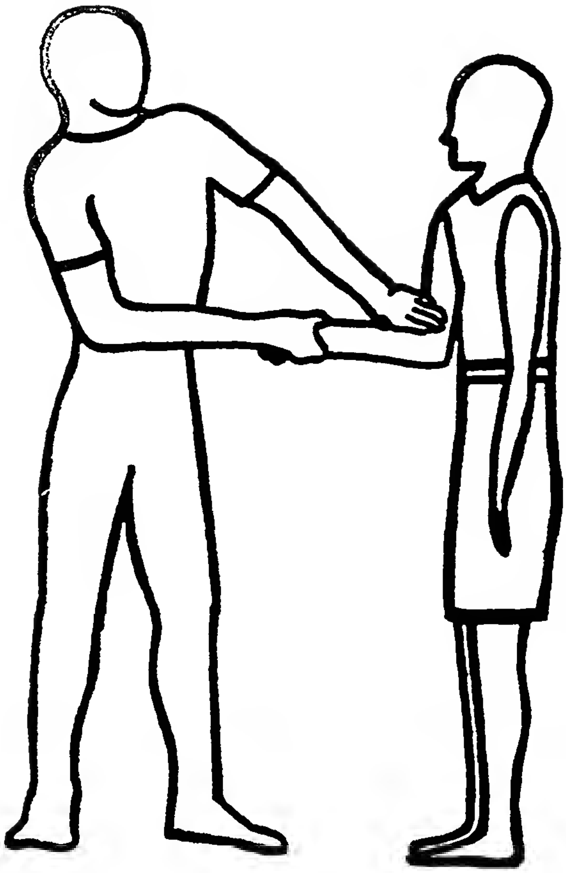


FIG 87. To show the grip for applying traction to the fore-arm . (i) to exert traction on the carpal and radio-menisco-carpal (i e , true wrist) joints , (ii) to pull the radius downward on the ulna in the long axis of the fore-arm (See also Fig. 88) The mobilising force is trunk rotation to the right.

Antero-Posterior Movement — Mid-carpal Joint

If now the stabilising hand grasps the back of the fore-arm bones just proximal to the wrist region, and the mobilising hand, placed an inch or so away, grasps the back of the patient's hand, it will be found that a wide range of antero-posterior mobility can be secured. The extent of this range of movement is seen in Figs. 89 and 90, and it will be observed that most of the movement takes place at the mid-carpal joint. (See Figs. 91 and 92.) In order to secure the full range of movement, one condition is essential, namely, that the mobilising hand should not aim at travelling in a direction directly antero-posterior, but rather the index finger of the mobilising hand should travel definitely and discernibly towards that of the stabilising hand. The maximum range of movement is secured when the patient's hand is slightly palmar flexed. There is comparatively little movement to be secured from the mid-position in a backward direction. The mobilising force is exerted entirely from the elbow ; fingers and wrist (which should be dorsi-flexed) remaining as rigidly fixed as possible.

FIG 88 To show an alternative technique for exerting traction when the mobilising force consists of flexion of the patient's elbow (For further detail of the mechanical effect see p 181, par 2)

2. The Radio-menisco-carpal Joint

The antero-posterior movement of the proximal row of carpal bones upon the radius and the meniscus presents a curious contrast to the corresponding movement at the transverse inter-carpal joint ; it is far more difficult to perform and the range is relatively minute. The technique of this movement is peculiar in that to a certain extent both hands have to perform stabilising

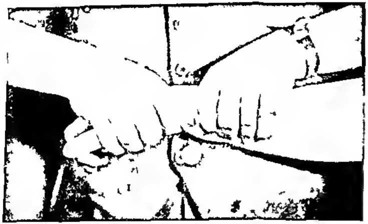


Fig 89 To show the antero posterior movement that takes place between the hand and the fore arm The hand is here shown moved towards the dorsum of the fore arm The X ray appearance shown in this movement can be seen in Fig 91

Fig 90 To show the antero posterior movement of the hand upon the fore arm the hand being moved towards the palmar aspect Note there is no flexion or extension of the hand See also Fig 92 for the X ray appearance Note the extent to which the movement takes place at the mid carpal joint In practice the index finger of the mobilising hand approximates more nearly to that of the stabilising hand than is indicated here Too wide a gap had to be left between the two hands (so as to show the grips taken) to show the approximation accurately It is to be seen to greater advantage in the X ray photos Figs 91 and 92

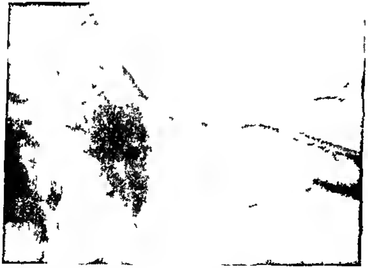


Fig 91 X ray appearance of the bones and joints when the hand is held in the position shown in Fig 89

Fig 92 X ray appearance of the bones and joints when the hand is held in the position shown in Fig 90

and mobilising functions at the same time. The patient's hand is placed in a slight degree of palmar flexion and the two thumbs then examine for the tubercle on the back of the lower end of the radius. Having found this they are placed close together on the back of the wrist region and both point directly parallel with the long axis of the fore-arm bones. (See Fig. 93.) It is essential that the tips should rest just distal to the back of the lower end of the radius. The two index fingers are then placed transversely across the anterior aspect of the patient's carpus, their tips in contact with one another in the middle line. The thumbs and the forefingers thus grasp the proximal row of carpal bones between them and hold rigidly in this position. The mobilising force is now exerted by a minute ulnar deviation of both hands simultaneously, while the grasp of the fingers and thumbs remains firm without actually pinching. As the mobilising hands drop into ulnar deviation the tips of the thumbs are driven up against the lower end of the patient's radius. Then the two hands are carried upwards simultaneously and together as far as they will go but, as there is relatively little deviation possible in the mobilising wrists in this direction, the movement is performed mainly by means of pronation of the two fore-arms. Doubtless, a certain amount of supination is used when exerting the mobilising force which carries the proximal row of carpal bones backwards on the lower surface of the radius, but it is quite insignificant compared with the degree of pronation which is required when the movement is being impressed in the opposite direction. Unfortunately, the degree of movement is too small to show clearly in photographs. The degree of movement that takes place is seen in Figs. 94 and 95.

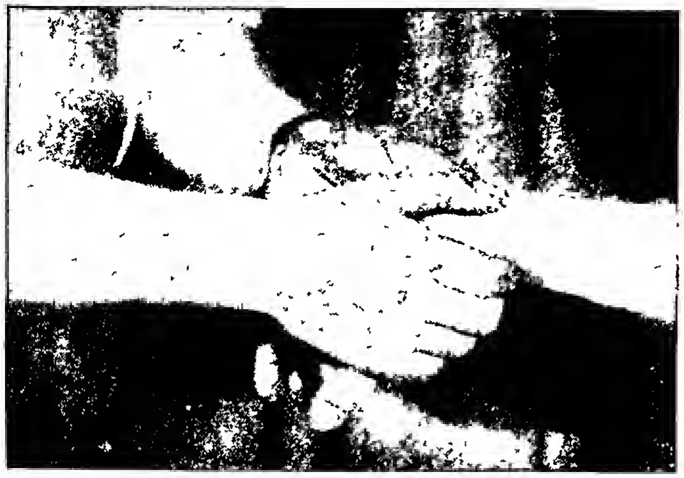


FIG 93 To show the grip for moving the proximal row of the carpal bones in an antero-posterior direction on the radius (*Cf* Figs 94 and 95)

FIG 94 To show the X-ray appearance of joints during the movement shown in Fig 93 when the carpus is moved towards the palmar aspect (See also Fig 95)

There is an alternative and extremely useful method of attaining the same end as that already described, though as a result of this manœuvre the

transverse inter-carpal and the true wrist joints are both mobilised at the same time The main stress of the mobilising force is however, upon the transverse inter-carpal joint It is a matter of common knowledge that when the hand is resting in the straight position, the carpal bones project forward on the anterior aspect to a considerable extent beyond the anterior aspect of the fore-arm When, however, the hand is dorsi-flexed, these prominences of the carpal bones are withdrawn and a perfectly flat surface remains (See Figs 96 and 97) Thus, if the patient's hand is dorsi-flexed and the thenar eminence of the stabilising hand is placed opposite the point where the prominence of the carpal bones will appear when the hand is brought into the straight line, we have all the essentials for the purpose of the movement (See Figs 98 and 99) The base of the thumb having been placed as already described, the fingers of the stabilising hand close round the lower part of the back of the fore-arm bones, the mobilising hand is then placed over the dorsum of the patient's hand and the mobilising force is exerted by carrying the patient's hand round the arc of a circle so as to attempt to assume the straight position As already stated the thumb of the stabilising hand is there to prevent the assumption of this position, and therefore this rigid obstruction to movement develops into the mobilising

FIG 95 To show the X ray appearance of the joints during antero posterior movement of the carpus on the radius when the carpus is moved towards the dorsal aspect

FIG 96 To show the gap left underneath the lower end of the radius when fore arm and hand rest simultaneously on a flat surface (*Cf* Fig 97)

FIG 97 To show how the space shown underneath the lower end of the radius disappears when the hand is dorsi flexed The flat surface is attained when the hand is about in the mid position between the straight line and full dorsi flexion

FIG 98 To show the starting position for securing antero-posterior mobility in the transverse inter-carpal joint and in the true wrist joint (*Cf* Fig 99) The right hand is the stabilising hand and remains rigidly fixed The elbow of this side should be glued rigidly to the side of the body This could not be shown here without interfering with a free view of the more important grips and relative positions of the two hands

force. As the prominence of the carpal bones again descends forward to form the natural contour on the anterior aspect just distal to the wrist joint, it necessarily follows that the bones are pressed backwards with considerable vigour. In ordinary life, when the hand is in a straight position, a definite dip can be felt over the back of the carpal region. When this movement is performed the dip is converted into a convexity.

3. Movements of the Joints of the Meniscus

The next movement is one of extreme complexity and consists of the mobilising of the joints distal to the head of the ulna. Here we are dealing with the joints between the meniscus and the carpus and between the meniscus and the lower end of the ulna. The technique is difficult. If we are dealing with the patient's right hand, the forefinger of the manipulator's right hand is flexed so as to form a hook. (See Fig. 100.) This is placed over the palmar surface of the patient's hand so as to surround the pisiform. The thumb of this hand is then placed over the back of the shaft of the ulna, just proximal to the head of the bone. The thumb of the other hand is then placed directly distal to the prominence formed by the head of the ulna and over the dorsal aspect of the meniscus, set a trifle obliquely so as to be able to press forwards and slightly towards the radius at the same time as it pushes the meniscus mainly forwards. The fingers of this hand close naturally round the radial side of the wrist region in such a position as to be able to control any antero-posterior movement at this point. The bent forefinger that surrounds the pisiform is then adducted towards the thumb that rests over the back of the shaft of the ulna; this is placed directly horizontal to the long axis of the bone, and the mobilising force is the adduction of the thumb towards the palm in the direction of opposition. It must not merely be adducted towards the index finger. When the movement has reached its maximum the grip is relaxed, and then the thumb of the opposite hand, by an almost identical movement, impresses a force upon the back of the

FIG 99 To show the end position of the movement begun in Fig 98

meniscus The force applied during the first portion of the movement is directly antero-posterior, but that applied during the second part of the movement should be oblique—forwards and towards the radial side A very wide range of movement can thus be secured, but the tendency is to impress a movement of palmar flexion and dorsi-flexion of the hand, or, alternatively, of rotation of the fore-arm Every endeavour must be made to prevent either of these two movements from taking place

Fig 100 To show the grip for mobilising *the joints above and below the ulnar* meniscus

4 Flattening and Re-arching the Carpal Arch

The next movements that are not under voluntary control are the flattening and increasing of the carpal arch To perform the first of these movements the thumbs are placed across the dorsum of the patient's wrist and parallel to one another so as to form a hinged bar across the back of the joints (See Fig 101) The first finger on the ulnar side is then curled up into the form of a hook, as when manipulating the joints in the neighbourhood of the meniscus, and thus encircles the pisiform (See Fig 102) The first finger on the other side assumes a similar position over the tubercle of the scaphoid The impressed force is now exerted so as to flatten the arch by approximation of the two thumbs, which press directly forwards, while the two first fingers drag the two extremities of the arch backwards and, at the same time, away from one another The mobilising force is mainly shoulder rotation Then, in order to re-form the arch, the knuckles of the two index fingers are brought together while the thumbs separate from one

Fig 101 To show the grip for increasing the carpal arch The index fingers take the same grip as that shown in Fig 102

Fig 102 To show the grip for flattening the carpal arch (See Fig 101)

another. These then exert a powerful pressure on the extremities of the arch not antero-posteriorly, but towards the point where the forefingers are meeting together on the palmar aspect of the patient's hand. The wrists, fingers and thumbs of the mobilising hands should be fixed as rigidly as possible, the main mobilising force being fore-arm rotation performed simultaneously by both fore-arms. The range of movement secured, though slight, is very definite.

An alternative method of increasing the carpal arch is to grasp the carpus of the patient's hand between thumb and index finger, the thumb resting over trapezium and trapezoid, the first finger just distal to the head of the ulna. Both lie directly transverse to the long axis of the patient's fore-arm. The mobilising force consists of adduction of thumb and first finger, the bones of the carpal arch being compressed between the palmar surface of the distal phalanx of the thumb and the lateral aspect of the middle phalanx of the index finger.

FIG 103 To show the grip for performing lateral deviation of the hand This shows the full degree of radial deviation, while Fig 104 shows the full degree of ulnar deviation

FIG 104 To show the end of the movement started in Fig. 103 Note how the thumbs have approximated and the index fingers have separated (See also Figs 105 and 106)

5. Rotation of the Hand on the Fore-arm at the Radio-menisco-carpal Joint

It is often stated that there is no rotation between the carpal bones and the lower end of the radius; this is not so. (See Figs. 77 to 80, p. 85.) The degree of movement is by no means negligible and, therefore, every precaution should be taken to see that the movement is intact before attempting to perform the movements which are under voluntary control. The stabilising hand grasps the back of the patient's fore-arm proximal to the wrist region; the mobilising hand grasps the back of the patient's hand in a manner exactly similar to that which was used when performing the antero-posterior movement of the transverse inter-carpal joint. The mobilising force is exerted mainly by rotation of the fore-arm of the hand that grasps the dorsum of the patient's hand.

Movements Under Voluntary Control

Dorsiflexion and Palmar Flexion of the Hand

When we come to the consideration of those movements which are under voluntary control, these consist of dorsi-flexion and palmar flexion of the hand and ulnar and radial deviation of the hand It has already been shown that dorsi-flexion of the hand takes place mainly at the transverse inter-carpal joint, and, if the distal row of carpal bones is not free to rotate around the distal surface of the proximal row, dorsi-flexion is surely limited If now an attempt is made to secure dorsi-flexion without restoring the movement between the two rows of carpal bones, a most undue strain will be laid on the joints between the radius and meniscus on one side and the proximal row of carpal bones on the other In other words, the true wrist joint is liable to receive a very severe strain hence the utter disaster that so often follows injudicious and unscientific manipulation of this region

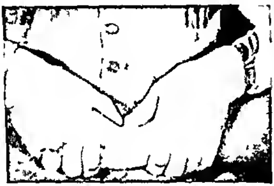


FIG 105 To show an alternative grip for performing lateralisation of the hand This shows radial deviation (*Cf* Fig 106)

FIG 106 To show the grip taken for performing ulnar deviation using the corresponding grip to that shown in Fig 105 The range of movement that takes place is seen in Figs 73 and 74 p 83

Abduction and Adduction of the Hand

Very little need be said about the lateralising movements beyond the fact that if these are limited, the two hands grasp the two sides of the patient's hand, which is held with the dorsum uppermost With the patient's hand held in the same straight line as the fore-arm bones, the wrists of the mobilising hands are fixed and the elbows are swung away from the sides, and then the movement is carried out in the reverse direction in the corresponding manner (See Figs 103 and 104) An alternative method is to place the thumbs in close contact with one another over the joint-line at the place where, during normal motion, the maximum concavity will appear, first on the radial side, then on the ulnar side The fingers of one hand grasp the lower end of the fore-arm, those of the other grasp the hand transversely (See Figs 105 and 106) The mobilising force is simultaneous ulnar adduction of both hands together

It must, however, be emphasised once more that it is not justifiable to attempt, by the use of force, to restore those movements that are normally under voluntary control until every attempt has first been made to secure freedom of mobility for those movements that are not so

On the upper surface of the radius there is an articular facet, concave, very shallow and again relatively very small when compared with the corresponding surface on the lower end of the humerus with which it articulates. When we examine the lower end of the humerus we find that the joint surface with which the radius articulates is very considerably wider than the transverse diameter of the head of the radius, and towards the inner side there is a sharp medial ridge running in an antero-posterior direction, separating the area which provides articulation for the ulna from that provided for the radius. (See Fig. 113.) Moreover, the ulnar articular surface on the lower end of the humerus is relatively narrow behind and becomes broader as we pass forward, finally diminishing again in front to a width roughly correspond-

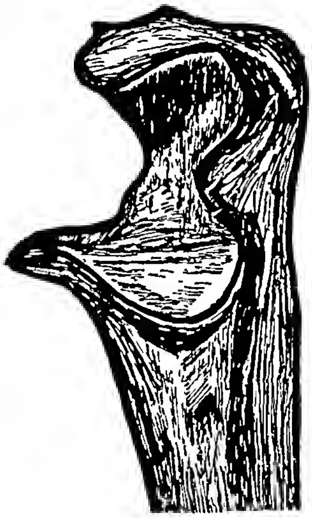


FIG 111 To show the contour of the surface on the ulna that articulates with the head of the radius Note that it is roughly pear-shaped—broad behind and narrow almost to a point in front

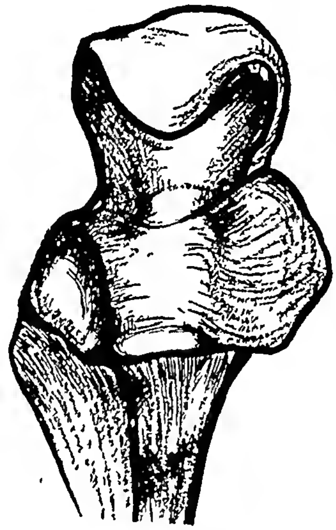


FIG 112 To show the "set" of the articular surface on the ulna at the superior radio-ulnar joint The buttress of bone at the back must tend to help to prevent the head of the radius from slipping backwards, but there is no such provision to prevent it slipping forward Indeed, the neck of the pear-shaped surface shown in Fig 111, and the fact that the arc formed by this surface as a whole is so much greater than the corresponding arc of the head of the radius, indicate that there is normally some degree of antero-posterior mobility of the head of the radius on the ulna

ing with that of the posterior limit of the articular surface. (See Fig. 114.) This, of course, can only mean that the olecranon—equally, of course, carrying the fore-arm with it—is free to travel laterally on the lower end of the humerus while the fore-arm is in a state of moderate flexion. (*Cf.* Figs. 136 to 138, pp. 113 and 114.) The movement becomes more limited as extension or flexion becomes complete.

Movements Not Under Voluntary Control

Traction

It has already been seen that the first movement that can be performed which is not under voluntary control is the result of traction. It is administered with the same grip as was shown when applying traction to the carpal bones, (see Fig. 87, p. 90), and the result of the movement is illustrated in Figs. 115 and 116, p. 102. The mobilising force is exerted (by the hand that grasps

the carpus of the patient) in the long axis of the patient's fore-arm, and in addition to traction it is well to impart a slight degree of alternate pronation and supination to the fore-arm The stabilising hand is over the lower end of humerus as near the crease in the front of the fore-arm as possible, and the mobilising force is partly humeral abduction and this is partly combined with trunk rotation While applying traction to mobilise the carpal joints it is immaterial how the patient's fore-arm is placed as regards rotation, provided there is no rotation of the hand upon the fore-arm, but when applying traction to mobilise the radio-ulnar joints it is imperative that the patient's fore-arm should be in the mid-position of rotation It is in this position that the ligaments will allow the greatest range of mobility

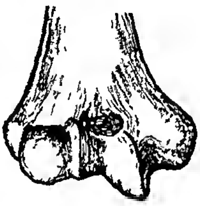


FIG 113 To show how the articular surface on the lower end of the humerus with which the ulna articulates narrows above Note the obliquity of the inner edge of the articular surface the outer being almost dead vertical Thus the articular surface of the humerus which is in contact with the ulna broadens in front from above downwards and the same applies in lesser degree on the posterior aspect (See Fig 114) This also shows the ridge that separates the ulnar from the radial articulations

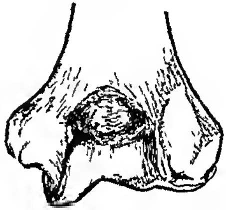
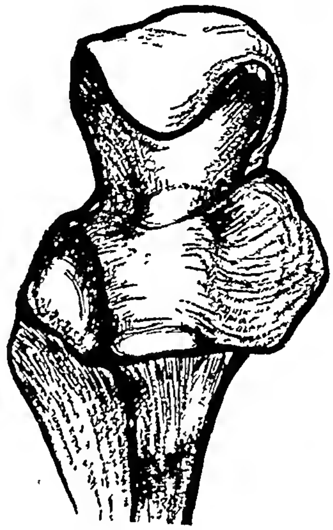


FIG 114 To show how the articular surface on the lower end of the humerus with which the ulna articulates also narrows above on the posterior aspect Note also as in Fig 113 the obliquity of the inner edge of the articular surface the outer remaining almost dead vertical Thus again the articular surface broadens as we pass from above downwards

It will be seen from the photographs that there is a very definite degree of mobility of the radius upon the ulna in the long axis of the fore-arm It necessarily follows, therefore, that, when traction is applied it is possible to pull the head of the radius downwards in the orbicular ligament while the relatively large depth of the articular surfaces on the upper and lower ends of the ulna when compared with those on the corresponding ends of the radius is the factor which allows of movement of the shaft of the radius on the ulna in the long axis of the fore-arm Two other factors must limit the downward movement the first is the grip of the orbicular ligament, and the second is the interosseous membrane and the interosseous ligaments Traction on the orbicular ligament which tends to pull it downwards towards the hand must, of necessity, tend to drag it into an oblique plane This in turn must tend to cause it to grip more tightly round the head of the radius At the lower end, too, as the lower interosseous ligaments ~~become~~ tighter they must tend to

On the upper surface of the radius there is an articular facet, concave, very shallow and again relatively very small when compared with the corresponding surface on the lower end of the humerus with which it articulates. When we examine the lower end of the humerus we find that the joint surface with which the radius articulates is very considerably wider than the transverse diameter of the head of the radius, and towards the inner side there is a sharp medial ridge running in an antero-posterior direction, separating the area which provides articulation for the ulna from that provided for the radius. (See Fig. 113.) Moreover, the ulnar articular surface on the lower end of the humerus is relatively narrow behind and becomes broader as we pass forward, finally diminishing again in front to a width roughly correspond-

FIG. 111 To show the contour of the surface on the ulna that articulates with the head of the radius Note that it is roughly pear-shaped—broad behind and narrow almost to a point in front



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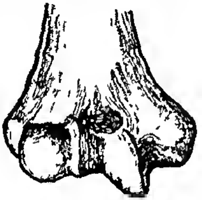

FIG 113 *To show how the articular surface on the lower end of the humerus with which the ulna articulates narrows above* Note the obliquity of the *inner* edge of the articular surface the outer being almost dead vertical *Thus the* articular surface of the humerus which is in contact with the ulna broadens *in* front from above downwards and the same applies in lesser degree on the posterior aspect (See Fig 114) This also shows the ridge that separates the ulnar from the radial articulations

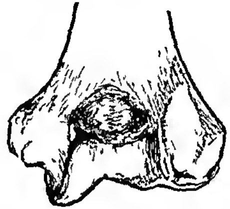

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FIG 115 To show, when compared with Fig 116, how the radius can be moved freely through a definite, if limited, range upon the ulna in the long axis of the fore-arm Here traction has been applied and the articular surfaces on the lower ends of the radius and ulna will be seen to form an almost continuous arc.

FIG 116 To show the effect of upward pressure on the lower end of the radius as applied in Figs 117 and 118 It will now be seen that the lower end of the ulna projects to a considerable distance distally beyond the lower end of the radius The arc seen in Fig 115 is sharply broken

bind the two bones more firmly together. From these two facts we have at once the explanation of the nature of the lesion commonly known as the "pulled elbow."

Upward Movement of the Radius in the Long Axis of the Fore-arm

If it is desired to overcome a lesion caused by traction, it is obvious that the remedy is to reverse the force by applying upward pressure. In order to effect this the mobilising hand grasps that of the patient by interlocking the thumbs, and then the wrists of both manipulator and patient are dorsi-flexed to a right angle. The stabilising hand grasps the back of the humerus and the patient's elbow is bent to a right angle ; the fore-arm of the stabilising hand is placed directly parallel with that of the patient, and this, again, is directly parallel with that of the mobilising fore-arm. (See Fig. 117.) Now adduction of the shoulder of the mobilising hand will tend to push the head of the radius upwards towards the humerus and the lower end of the radius upwards on the lower articular surface between it and the ulna.

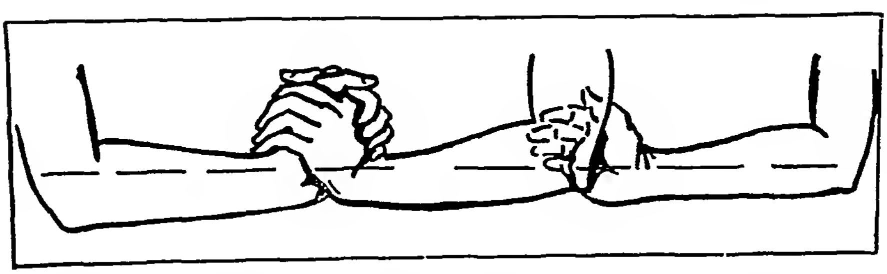


FIG 117 To show the grip for applying longitudinal pressure upon the fore-arm in order to force the radius upwards in the long axis of the fore-arm

It will be seen in a few moments that the upper end of the radius is only locked on the articular surface of the humerus when the elbow is in full flexion and full extension, and it is thanks to this mobility of the radius in the long axis of the fore-arm that we are able to perform lateralisation of the fore-arm on the humerus when the elbow is slightly bent (See Fig 136, p 113)

The upward movement of the radius on the ulna in the long axis of the fore-arm is also limited by the head of the radius coming into contact with the lower end of the humerus

An alternative method of pushing the radius upwards on the ulna is to place the patient recumbent with the fore-arm vertical The stabilising hand fixes the lower end of the humerus to the couch, the mobilising hand assumes the grip shown in Fig 118 and presses vertically downwards towards the couch

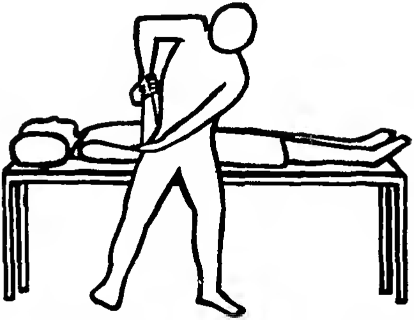


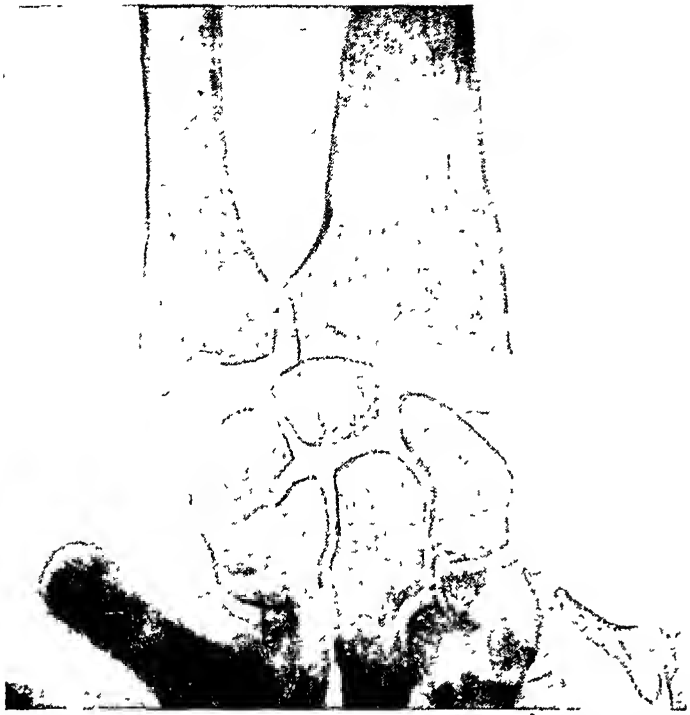
FIG 118 To show the method of applying pressure upwards in the long axis of the fore arm when the patient is recumbent The operator's body is twisted farther round than is desirable so as to allow a full view of the more important position of the two vertical fore arms

If, in the manner already described, the radius is pulled downwards upon the ulna until a definite locking takes place, not only will fore-arm rotation be limited, but there will be pain and discomfort in the elbow region If, on the other hand, the radius has, while the elbow is partly flexed, been pushed up to an undue extent towards the humerus and has remained fixed in this position, any attempt to secure either full flexion or full extension of the elbow will bring the head of the radius into firm contact with the lower end of the humerus at an earlier point than occurs during the performance of the normal range of movement Hence both flexion and extension of the elbow become limited and painful We have here the key to the dramatic success that often follows so-called manipulation of the elbow as a matter of fact, the beneficial result is often rather the effect of manipulation on the radio-ulnar joints than of manipulation on the elbow itself

Antero-posterior Movement of the Inferior Radio-ulnar Joint

The third movement that is not under voluntary control is the antero-posterior movement of the head of the ulna on the radius

At the lower end of the fore-arm, except when it is either held in full pronation or full supination, there is normally a very wide degree of antero-



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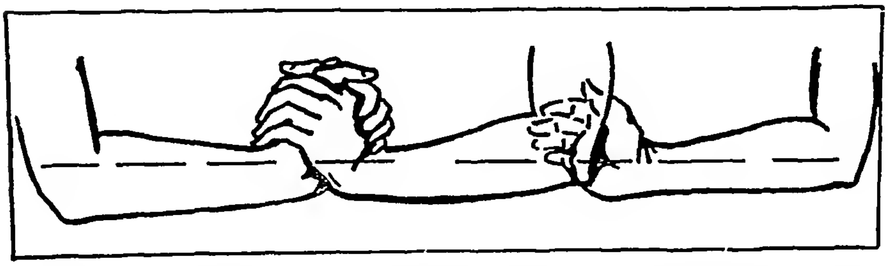

FIG 117 To show the grip for applying longitudinal pressure upon the fore-arm in order to force the radius upwards in the long axis of the fore-arm

rigid It is impossible to perform this movement in strict conformity with anatomical and physiological considerations, to satisfy these completely it would be necessary to stabilise the ulna and move the radius upon it This, however, seems to be entirely impracticable, owing in the first place to the extreme difficulty of stabilising the lower end of the ulna, and, in the second place, we should be left with an unwieldy mass in what would be the mobilising hand—so unwieldy that the movement secured would be ludicrously small in

Fig 120

Fig 121

Figs 120 and 121 To show the antero posterior mobility of the head of the ulna on the radius when the fore arm is in the mid position of rotation (120) the head of the ulna is pushed forward (121) it is pulled backward This proves the laxity of the inferior radio ulnar ligaments in the mid position In full pronation and full supination this movement becomes impossible

range compared with that secured by stabilising the radius and mobilising the ulna upon it

Movement of the Head of the Radius

The fourth movement that is not under voluntary control concerns the head of the radius At the upper end of the bone we have already seen that the orbicular ligament which surrounds it is not a completely stable structure, but can yield when traction is applied to it We have also seen that towards the back of the superior radio-ulnar joint on the ulnar side there is, as it were, a buttress of bone which must render it very difficult for the head of the radius to slip backwards as the result of any but extreme force (See Fig 112, p 100)

posterior mobility of one bone upon the other. In full pronation or full supination the ligaments are in full tension, and the movement is reduced to zero; it gradually increases in range until the mid-position in rotation is reached, when the greatest degree of mobility can be secured. This is only what we should have expected from what has already been said concerning the shapes of the articular facets of the inferior radio-ulnar joint. We then saw how the arc of the ulnar facet is far wider than that of the radial facet, so that only a relatively small portion of the latter can be in contact with the articular facet on the ulna at any one time. There is nothing whatever, therefore, to prevent antero-posterior mobility of one bone on the other at this point so far as the articular contours are concerned. The only limitation would be set by the ligaments, and these are only taut in full pronation and full supination. The flattening noted on the side of the head of the ulna (see Fig. 108, p. 98), must necessarily cause a slackening of the ligaments of the joint directly movement starts, either from full pronation or full supination, and it is this slackening that permits the antero-posterior movement of one bone upon the other to take place, the maximum being reached in the mid-position of fore-arm rotation.

The stabilising hand grasps the hand of the patient with the first finger resting in the cleft between the patient's finger and thumb, the thumb grasping the back of the hand of the patient, the fingers lying in front of the proximal part of the palm, and the palm of the hand resting against the outer side of the wrist and lower fore-arm region. (See Fig. 119.) The range of movement is shown in Figs. 120 and 121. Having secured this grip and having placed the patient's fore-arm in the mid-position of rotation, the thumb of the mobilising hand is placed over the back of the ulna just proximal to the head, while the first and second fingers grasp the front of the shaft of the bone on the opposite side. The thumb and fingers are placed directly transverse to the long axis of the shaft of the bone. Now the elbow of the stabilising hand is placed up against the body of the manipulator (or, if the patient is recumbent, the whole of the back of the patient's arm rests upon the couch), the wrist of the mobilising hand is fully dorsi-flexed and the head of the ulna is carried to and fro in antero-posterior direction. The mobilising force is impressed from the shoulder; the fingers, wrist, fore-arm and elbow remain

Fig. 119 Grip for performing the antero-posterior movement of the head of the ulna on the radius The fore-arm is held in the mid-position and the stabilising hand exerts control so as to prevent all movement of the joints of the patient's hand and fore-arm except the movement of the ulna on the radius Note the transverse grip of the mobilising hand on the neck of the ulna The mobilising force is impressed by movement of the shoulder The range of movement is seen in Figs 120 and 121

backwards upon it In order to perform this movement the stabilising hand grasps the fore-arm of the patient just proximal to the wrist joint and places the fore-arm in full supination (See Figs 122 123 and 124) The thumb of the mobilising hand is then placed against the upper end of the fore-arm of the patient with the thenar eminence resting directly over the head of the radius Now the stabilising hand flexes the patient s elbow in supination until the mobilising hand is wedged firmly in the angle formed between the front of the fore-arm and the front of the arm The thumb in the crease of the elbow which exerts the mobilising force now remains firmly fixed while the other hand which has hitherto mainly acted as a stabilising hand swings the patient s fore-arm round into pronation thus driving the upper end of the radius firmly against the thumb which is resting in the crease of the elbow This hand at the same time increases the backward pressure thus exerted by a slight movement of pronation of the fore-arm Hence, strictly speaking it is not accurate to speak of either hand as stabilising or as mobilising since when the final impressed force is exerted both hands must work in unison

FIG 125 To show how the base of the radius should be moved around the head of the ulna during the performance of the movement of pronation Both thumbs rest on the back of the radius and the index finger of the hand holding the head of the ulna is curled up so as to embrace it (See Fig 126 below)

Movements Under Voluntary Control

When it comes to the performance of those movements that are under voluntary control it will be obvious from what has already been said that considerations arise very similar to those which were made when performing flexion and extension of a metacarpo-phalangeal joint In other words unless the lower end of the radius is free to slide around the head of the ulna definite injury will be done to the ligaments on the front or at the back of the inferior radio-ulnar joint by forcible

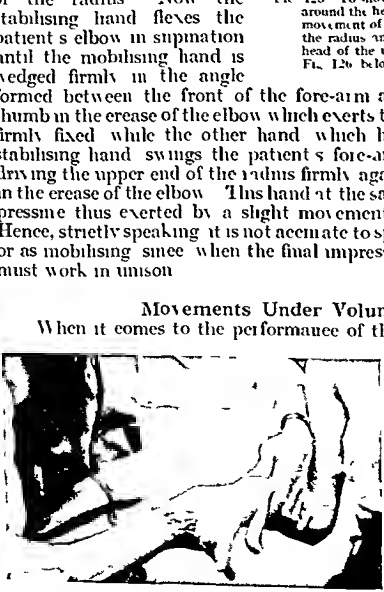

FIG 126 To show the end of the movement begun in Fig 125 (See above)

In a forward direction, however, there is no such impediment (see Fig. 111, p. 100), and if forces are allowed to act which will tend to pull the head of the radius directly forward, the "give" of the orbicular ligament is sufficient to allow a most deleterious forward movement of the head of the radius on the ulna to take place. The most likely force to cause this displacement is the

FIG 122 To show how the mobilising force can be impressed against the upper surface of the head of the radius when the thenar eminence of the mobilising hand is gripped between the opposing surfaces of the front of the fore-arm and of the arm when the elbow is flexed Unfortunately, no X-ray reproduction of this movement is possible owing to the impossibility of eliminating overlapping shadows thrown by the mobilising hand In practice, a far greater degree of flexion of the patient's elbow is enforced (*Cf* Fig 124) Here, less flexion is shown for the sake of clearness of reproduction

FIG 123 To show the end of the movement begun in Fig 122 Note the pronation of the patient's fore-arm and the fact that the hand resting over the anterior aspect of the head of the radius has not altered its position of pronation materially in spite of the increased flexion of the elbow (*Cf* Fig 124)

FIG. 124 The same position as Fig 123 seen from behind Here the photo seems to show the thenar eminence pressing on the radius at a considerable distance from the elbow This is mainly a photographic misrepresentation, as the patient's arm is almost in a horizontal position, and the fore-arm foreshortened

sudden and unco-ordinated pull of the biceps tendon. As the result, if a "seizing-up" takes place, it is inevitable that the upper end of the radius will come into contact with the lower end of the humerus when the elbow is flexed, at a much earlier period than occurs during normal physiological movement. Therefore, if full flexion of the elbow is limited to a minute extent, and yields a sensation of weakness or of pain, it is always worth while first to pull the radius downwards on the ulna and then to press the head of the radius

backwards upon it In order to perform this movement the stabilising hand grasps the fore-arm of the patient just proximal to the wrist joint and places the fore-arm in full supination (See Figs 122, 123 and 124) The thumb of the mobilising hand is then placed against the upper end of the fore-arm of the patient with the thenar eminence resting directly over the head of the radius Now the stabilising hand flexes the patient's elbow in supination until the mobilising hand is wedged firmly in the angle formed between the front of the fore-arm and the front of the arm The thumb in the crease of the elbow which exerts the mobilising force now remains firmly fixed, while the other hand, which has hitherto mainly acted as a stabilising hand, swings the patient's fore-arm round into pronation, thus driving the upper end of the radius firmly against the thumb which is resting in the crease of the elbow This hand at the same time increases the backward pressure thus exerted by a slight movement of pronation of the fore-arm Hence, strictly speaking, it is not accurate to speak of either hand as stabilising or as mobilising since, when the final impressed force is exerted, both hands must work in unison

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When it comes to the performance of those movements that are under voluntary control it will be obvious from what has already been said that considerations arise very similar to those which were made when performing flexion and extension of a metacarpo-phalangeal joint In other words, unless the lower end of the radius is free to slide around the head of the ulna, definite injury will be done to the ligaments on the front or at the back of the inferior radio-ulnar joint by forcible

FIG 126 To show the end of the movement begun in Fig 125 (See above)

movement. The shaft of the ulna just above the head is not very substantial, leverage is great and the exercise of undue force may even cause a spiral fracture of the lower end of the shaft of the ulna, twisting off the head of the bone. Therefore, in order to perform rotation of the radius on the ulna the shortest possible leverage should be employed. *To perform pronation, the stabilising* hand supports the hand of the patient and fixes the elbow at a right angle; the first finger of the mobilising hand is then bent into the form of a hook corresponding to the grip already described for the manipulation of the joints in the neighbourhood of the ulnar meniscus. (See Fig. 100, p. 95.) The thumb rests transversely across the back of the lower end of the radius and the impressed force is exerted by the adduction of the thumb of the hand on

FIG. 127 To show the alternative method of moving the base of the radius around the head of the ulna during the performance of supination Note that the index finger of the mobilising hand is curled around the head of the ulna (See Fig 128)

FIG 128 To show the end of the movement begun in Fig 127 It can now be seen how the hook-like grip of the index finger around the head of the ulna levers it forward while the thumb presses at right angles to the anterior surface of the radius to push it backwards as well as into supination

the ulnar side towards the first finger during the whole range of movement of the radius round the head of the ulna. (See Figs. 125 and 126.)

The alternative grip for performing supination is seen in Figs. 127 and 128. When performing this movement, the hook formed by the first finger is placed around the lower end of the shaft of the ulna on the dorsal aspeet while the thumb levers the lower end of the radius round, being plaeed transversally across the lower end of the radius.

Sometimes it may be neeessary to expend a somewhat greater degree of foree in order to seeure the desired movement, but it must be applied so that the shaft of the radius is swung directly round the lower end of the ulna. In this event. to perform pronation, the palmar aspect of the thenar eminence of the stabilising hand is plaeed over the palmar aspect of the lower end of the ulna. while the corresponding part of the mobilising hand is placed over the back of the lower end of the radius. Both wrists are fully dorsi-flexed, and the mobilising hand on the back of the radius exerts an antero-posterior pressure

vertically against it The hand on the opposite side of the ulna remains immobile and the mobilising force is impressed from the shoulder on the side of the mobilising hand In order to perform supination with a corresponding grip, the position of the hands is reversed (See Figs 129 and 130)

It is vital to remember that, when performing either of these two movements, the direction of the impressed mobilising force must invariably be

FIG 129 To show the alternative grip for rotating the radius around the lower end of the ulna This shows the grip for pronation

FIG 130 To show the grip for performing supination of the fore arm

vertical to the long axis of the shaft of the radius, moreover, it must also be directly parallel to the position of the stabilising fore-arm Consequently, with every little gain in the movement of rotation the position of the grip of both hands requires alteration

It must also be remembered that in pronation the head of the ulna forms a marked prominence on the dorsum of the fore-arm, while in supination this almost vanishes This gives the main clue as to the pressure to be exerted by the two hands

CHAPTER IX

THE ELBOW

Anatomical Considerations

The elbow joint primarily consists of the articulation between the greater sigmoid cavity of the ulna and the lower end of the humerus. As has already been seen, the position of the head of the radius in relation to the humerus is not a stable one; and, this being so, the only positions during normal movement in which the upper end of the radius is actually in close contact with the lower end of the humerus are full flexion and full extension. Doubtless, in the movements of ordinary life, when the elbow is flexed and extended the head of the radius also rests lightly upon the lower end of the humerus, but from the point of view of manipulation it is wise to consider this position as not being a stable one.

When we examine the articular facet in the greater sigmoid cavity of the ulna (see Fig. 110, p. 99), we notice at once the high ridge that separates the whole surface into two parts, not only the vertical part but also the horizontal part. This ridge fits accurately into a corresponding groove on the lower end of the humerus. (See Fig. 113, p. 101). When, however, we come to examine this groove, we find that it narrows at the upper limits in front and behind (see Figs. 113 and 114), and therefore is broader at a distance from these two limits. Thus, although there can be no lateral deviation of the olecranon on the humerus in full flexion or full extension of the elbow, in the intermediate positions this movement becomes possible.

Then, too, in full flexion, the beak-like prominence of the tip of the coronoid fits accurately, and with no margin, into the fossa above the ulnar articular facet on the anterior aspect of the humerus. In similar manner the beak-like projection of the tip of the olecranon fits accurately into the hollow of the olecranon fossa of the humerus in full extension of the elbow. When movement is driven home in either direction the fit of the two facets is nearly exact, particularly that between humerus and olecranon.

If we now examine the fit at any point between full flexion and full extension we find that the articular facet on the humerus is wider than that on the ulna, and so lateral mobility must become possible at all these points.

Then, too, the inner side of the facet on the humerus throughout the whole range is raised—banked-up as it were. This causes an oblique setting of the inner part of the joint surface, and is responsible for the formation of the carrying angle.

The hollow on the articular surface of the humerus into which the corresponding ridge on the ulna fits from above downwards is to all intents and purposes exactly antero-posterior throughout its circumference.

It is worthy of notice that when the elbow is bent to about 10 degrees from full extension the narrowest part of the articular surface of the greater sigmoid cavity is directly opposite the broadest part of the corresponding surface of the humerus Here we see the reason why the lateral mobility of the fore-arm on the arm is greatest in this degree of flexion of the elbow

Finally, when we view the contour of the edge of the humeral articular facet from the side (see Fig 131), it will be seen that, although it is roughly circular if the curve were completed, at the upper end there would be a definite flattening Moreover, the humeral origin of the internal lateral ligament is placed rather behind the central point of the main arc It follows of necessity, therefore, that this lateral ligament is more taut when the elbow is bent beyond 30 degrees from the straight than it is when flexion is not so pronounced This ligament remains relatively slack when the elbow is merely straight, and does not become taut till extension passes on to a variable degree of what is commonly called hyper-extension It is at this point that we can see the reason why the articular facet on the coronoid is set somewhat obliquely from behind downwards and forwards, as this steers, as it were, the ulnar insertion of the ligament away from the central origin Thus, when hyper-extension begins, the ligament which has so far been relatively slack begins to tighten again as the movement of the ulnar insertion has become eccentric, till, when the limit of movement is reached, it allows no lateral play of the fore-arm on the arm On the outer side the same reasoning applies to that part of the ligament which passes down to be inserted on to the ridge that runs downwards from the back of the lesser sigmoid cavity

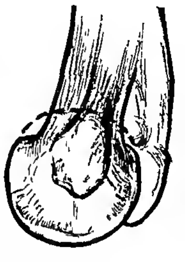

FIG 131 To show the contour of the articular facet at the lower end of the humerus when viewed from the inner side Note that although it follows approximately the arc of a circle below the continuation of the arc which would join the anterior and posterior limits of the articular surface is flattened Also note that the origin of the internal lateral ligament is not situated at the centre of the circular part

Movements Not Under Voluntary Control

Traction

As a preliminary to the manipulation of the elbow joint it is essential that the head of the radius should be pulled down quite firmly into the orbicular ligament before setting to work on the other movements which are not under voluntary control This is, strictly speaking, a matter of manipulation of the radio-ulnar joints, and the technique is fully described on pp 102-104 Then the head of the radius must be pressed backwards as described on p 106, if an adequate degree of flexion is possible if it is not, the technique must be modified accordingly by a direct pull backwards on the upper part of the shaft of the bone while the patient is recumbent and the elbow flexed to a right angle If this preliminary is omitted, and if the position of the radius is somewhat elevated in the long axis of the fore-arm with regard to the ulna, or if it is held somewhat forward in the lesser sigmoid cavity, not only will the

subsequent manipulation fail, but a considerable amount of damage may be done if it is attempted, resulting in severe reaction.

Grinding the Beak of the Olecranon into the Olecranon Fossa

The traction can be applied with the same technique as that described for pulling the radius downwards in the long axis of the fore-arm, the only difference being that it should be applied in the long axis of the fore-arm in the fullest degree of extension of the elbow that is available.

An alternative method is shown in Fig. 132. The grip on the carpus is the same but the position is reversed. The back of the arm of this hand is then brought into contact with the front aspect of the patient's arm as near the elbow as possible merely as the result of flexing this elbow. When the "slack" has been taken up, further flexion will exert a powerful mobilising force in the long axis of the fore-arm upon carpal joints, radio-ulnar joints and elbow joint.

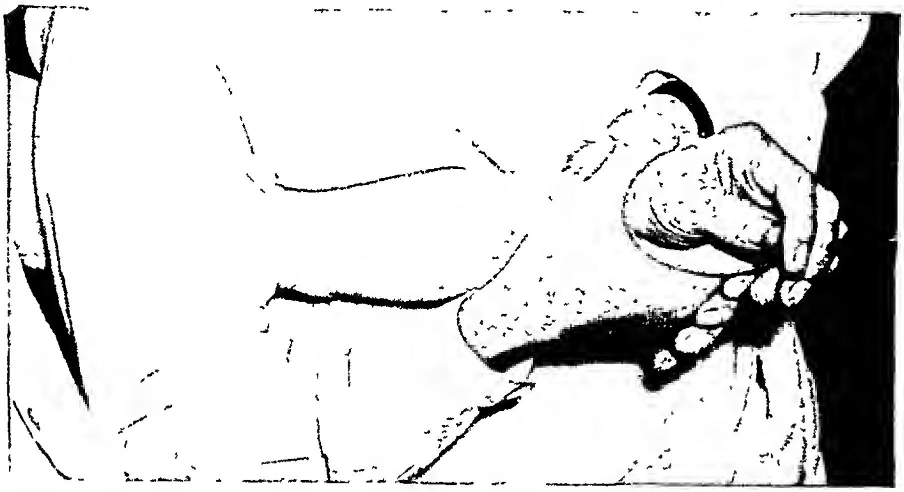

FIG 132 To show an alternative method of applying traction in the long axis of the fore-arm Flexion of the patient's elbow is the mobilising force, as by this means the back of the operator's arm is driven backwards on the front of the patient's arm The two arms must be at right angles to one another For explanation of the mechanics of the movement see p 181, para 2

When we come to the restoration of full extension the technique is similar whether the patient is in the upright or in the recumbent position, though the latter position is perhaps easier for the operator. When standing, the fore-arm is placed in full supination and the stabilising hand then holds the patient's fore-arm against his own trunk, the fingers gripping the fore-arm just above the level of the wrist joint. This becomes the stabilising hand. The mobilising hand then grasps the outer side of the patient's arm just above the elbow; the wrist of this hand is fully dorsi-flexed. Then the lower end of the humerus of the patient is carried directly to and fro towards the side of the body of the patient and away from it. (See Figs. 133 and 134, p. 113.) In the recumbent position the stabilising hand presses the lower end of the fore-arm downwards upon the couch in full supination and the mobilising hand carries the lower end of the humerus to and fro as in the standing position.

The mobilising force is performed entirely from the shoulder joint; but, in order that the lateral movement may be performed, the patient's elbow must be very slightly flexed at the time the movement begins. Then slowly, stage by stage. as the lateral movements are performed, the mobilising hand rises until the elbow is in full extension. The lateral movements to be

Fig 133 To show the grip for manipulating the elbow so as to secure full extension The hand over the humerus is the mobilising hand (Cf Figs 134 and 137)

Fig 134 To show continuation of the movement started in Fig 133 (Cf Fig 135)

Fig 135 To show the alteration of the grip which is required if the stabilising hand is placed over the lower end of the humerus The elbow is glued firmly to the side of the operator s trunk The hand which grasps the patient s fore arm becomes the mobilising hand (Cf Fig 136)

Fig 136 To show the range of lateral mobility of the fore arm on the arm The stabilising hand is grasping the arm above the lower part of the humerus (cf Figs 137 and 138) the main grip being taken between thumb and index The stabilising hand has moved slightly but only to a minute extent when compared with the mobilising hand

performed should be directed without variation in a line inwards and outwards, directly at right angles to the lower end of the shaft of the humerus. The result of this movement is, as it were, to grind the beak of the olecranon into the olecranon fossa. Normally, there is considerable range of hyper-extension at the elbow joint, and the extent of this should carefully be noted on the sound side before the movement is begun. When extension is complete, no lateral movement is possible, and the ligaments are in a state of tension. The faintest trace of release from the fully hyper-extended position at once allows a very

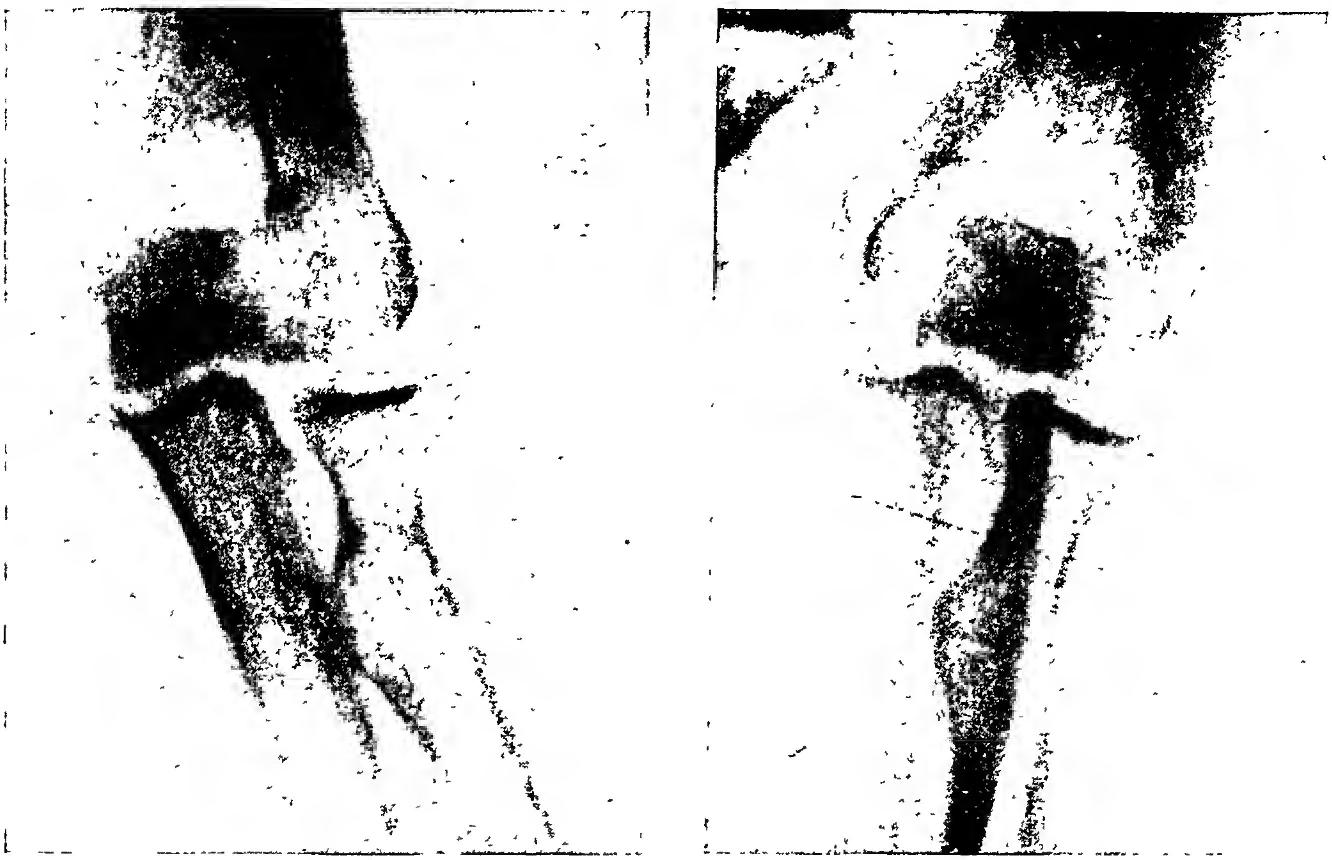

Fig 137 Fig. 138

Figs 137 and 138 To show the movement described as "grinding the beak of the olecranon into the olecranon fossa" (137) shows the fore-arm carried over into radial deviation, and (138) into ulnar deviation, the elbow in both instances being slightly flexed

Note that the space between the head of the radius and the humerus is much narrower in (137) than in (138), thus proving that the head of the radius is not in firm contact with the humerus once flexion has commenced Note also the different relationship of the olecranon to the lower end of the humerus

considerable range of lateral mobility of the olecranon on the humerus. Of necessity, this could not take place if the head of the radius were not able to move upwards and downwards in the long axis of the fore-arm with comparative freedom. Were it not free so to move, and were the lateral movement of fore-arm on arm to remain intact, the lateral ligaments of the elbow joint would of necessity be so slack that the stability of the joint would be lost.

An exactly similar movement can be performed by changing the hand which grasps the lower end of the humerus above the elbow into the stabilising hand (see Fig. 135, p. 113), while the hand which grasps the fore-arm above

the wrist is turned into the mobilising hand In the upright position the elbow of the stabilising hand is fixed firmly to the manipulator's trunk, while in the recumbent position the stabilising hand grasps the back of the humerus rather than the side of it so as to fix the humerus while the fore-arm is adducted and abducted The range of lateral movement is shown in Figs 136, 137 and 138 In Fig 136 the stabilising hand is grasping the elbow

Movements Under Voluntary Control

Flexion and Extension

Having succeeded in performing these movements, it is essential, whether the manipulation is being performed in order to secure increase of flexion or increase of extension of the elbow, that the movement of flexion should be performed first As a rule, unless flexion is relatively free extension must wait If the movement of extension is limited and we wish to regain it, as full flexion as is anatomically possible should be secured, and this must be coupled with the precautions already taken to secure that the head of the radius is pressed backwards in the orbicular ligament according to the technique described on pp 106 and 107 If flexion has been deficient, these simple manœuvres will sometimes serve to restore the mobility that has been lost

FIG 139 The cuff and collar sling applied to assist supination of the fore arm as well as flexion of the elbow

The main point about using force either to flex or extend a stiff elbow is to issue a word of grave caution to anyone who sets out to manipulate an elbow in which the degree of impediment to movement is anything but very slight If the limitation of flexion is more than a very few degrees, no attempt should ever be made to secure full flexion at one sitting After the first dead point is passed a collar and cuff sling should be applied

Although the description of apparatus of this sort is not strictly the function of the present work, I have been advised so often to give a short description of the use of this invaluable method of treatment that I am tempted to yield to persuasion The two main principles on which it is founded are that Patients as a general rule are able to restore extension by voluntary movement, but not to restore flexion in the same manner Provided any degree of movement is present, it is always worth while to try to see to what extent the flexion

can be restored by intermittent traction. For this purpose, a collar is placed around the neck and another around the wrist. These two are joined together by tape or string as tightly as the patient will tolerate and the idea is that every movement of the shoulder (which therefore, must of necessity be free to move), alters the traction on the lower part of the fore-arm bones. As the elbow moves forward, the traction tends to relax but as the shoulder travels backward, there is bound to be a traction on the elbow tending to flexion. Incidentally, this is a potent argument against the use of the cuff and collar in treatment of elbow fractures in children, unless there is synovial fluid between the fragments which will effectively prevent the formation of new bone. For these injuries, including simple dislocation of the fore-arm, the cuff and collar by itself, without limiting the movement of the shoulder in addition, allows a degree of freedom of movement vastly in excess of the amount which should be allowed. Day by day the cord that joins the cuff round the wrist to the collar round the neck, is tightened, regardless of the fact that there may be some loss of extension. Then, when the hand has reached the position where the thumb can rest on one side of the neck and the index finger on the other side, the traction of the cord is somewhat relaxed. The next day the patient is asked to restore the full degree of flexion that had been secured by purely voluntary muscle action. If this is impossible, the cord is tightened again for a few days before the process is repeated. As soon as the voluntary return to flexion has been restored, the traction of the cord is relaxed further say by about an inch, and the next day, if the range of voluntary flexion has not been lost, a further lowering of the cuff is allowed. And so we proceed until the voluntary flexion is found to be diminishing. Directly this is noted, the cord is tightened again until the original degree of flexion has been restored. Two days later the process is repeated and it is usually wise to continue the process at least until the movement from flexion to 20 degrees of extension beyond the right angle is under voluntary control. Once this degree of freedom of movement is restored, it is usually possible to remove the support and continue active training of the triceps action so as to restore the lost extension.

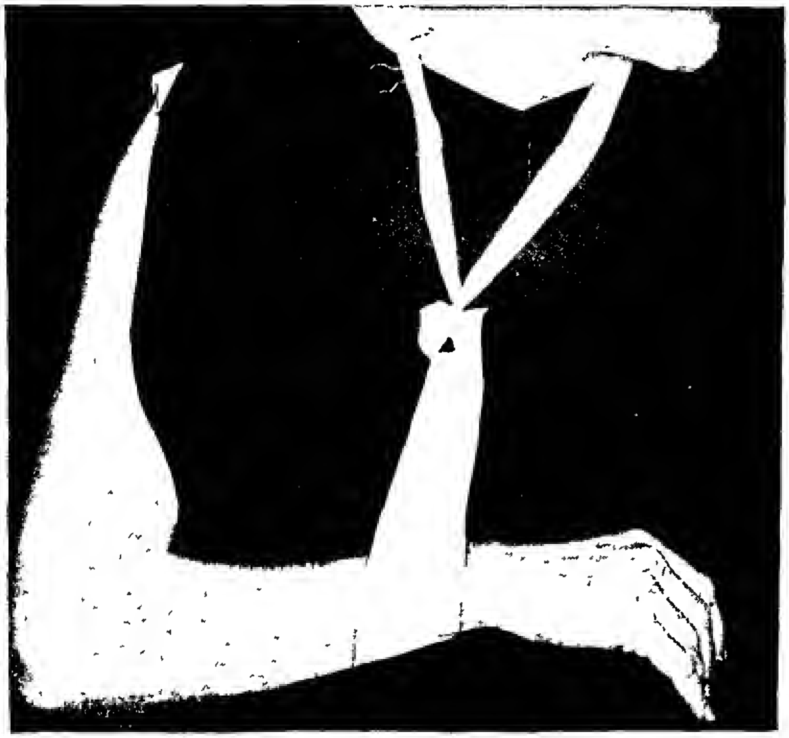

FIG 140 The same as 139, but the support now assists pronation

But even so, should the power of full voluntary flexion show any sign of being lost again, the cuff and collar traction must be resumed immediately until the original degree of flexion has been restored. It is no uncommon event for fore-arm rotation to be lost simultaneously with the loss of elbow movement, and in this event, it is quite easy to arrange for the cuff and collar principle to be applied while applying rotation in either direction. The photographs shown should be self-explanatory. (See Figs. 139, 140 and 141.) When slinging in pronation, a short posterior splint may be required to prevent the tendency to wrist drop. (See Fig. 141.)

So, too, if extension is limited more than very slightly, no attempt should be made to force full extension. While performing flexion it is always wise to place the patient recumbent with the stabilising hand placed between the back of the patient's humerus and the couch, in such a position that the lower end of the bone can be grasped firmly between fingers and thumb. Then the patient's fore-arm is fully supinated and the hand is led upwards towards the shoulder. As soon as the limitation of movement is reached, pressure is exerted until the first dead point has been passed. In no circumstances should any further movement be impressed. In order to ensure that this shall be so, the hand responsible for the movement of the fore-arm should grip the fore-arm not lower than the middle of the ulna.

FIG. 141. To show how both elbow flexion and pronation pulls can be increased by altering the position and obliquity of the support. It also shows the need for a posterior wrist splint.

So, too, when performing extension in the lying position the stabilising hand rests upon the front of the humerus and presses it firmly down upon the couch. The mobilising hand, again grasping the fore-arm not lower than the level of the middle of the ulna, holds the fore-arm in supination and presses it downwards towards the couch. The thumb of the mobilising hand should rest on the head of the radius so as to press it backwards firmly while the extending mobilising force is applied with the other hand. (*Cf.* Fig. 142.) Once more, as soon as it is felt that the smallest degree of increased range of movement has been gained, the movement must cease instantly.

It must always be kept in mind that forcibly to move the elbow in either

direction after the first "dead-point" has been passed is liable to lead to the utmost disaster. It is true that there is slightly less danger when restoring flexion than when trying to increase extension, but it is far better to err on the side of safety even when trying to increase the range of flexion. Neglect of this warning is always liable to lay undue strain upon the internal lateral ligament. This causes undue traction on the bone at the humeral origin, which here consists almost entirely of cancellous tissue. The bone is more friable than the ligament, and comparatively little force is needed to cause damage to be done to the surface of the bone. The result of undue tension on this bone is the exact equivalent, from a clinical standpoint, of fracture without displacement of the internal epicondyle. It is common knowledge that, if movement is enforced after this accident, or after a fracture through the olecranon fossa, an excess of callus will be formed which will impede the full restoration of function for at least nine months and, possibly, longer. Indeed, it may prevent complete recovery from taking place at all.

FIG 142 To show how the thumb of the mobilising hand should guard the head of the radius during manipulation designed to increase extension in a stiff elbow (standing position)

When it appears that full extension has been secured it is wise to confirm this by the following manœuvre. One hand is placed round the back of the patient's humerus just above the elbow joint; the other hand then secures a loose grasp of the region of the patient's wrist. The fore-arm is then carried up in a position of mid-pronation over the front of the chest into full flexion, and then it is carried downwards so as to increase the carrying angle to the uttermost extent, full supination being added slowly. Gradually the fore-arm is led downwards towards the extended position, pressure calculated to increase the carrying angle as far as possible being still maintained. (See Figs. 143 and 144.) Then, when the limit of movement is reached, and it appears that the elbow is fully extended, the hand grasping the lower end of the humerus must be rigidly fixed while the mobilising hand—after once more making sure that supination is complete—carries the fore-arm over towards the side of the patient's body. This involves the carrying of the inner side of the patient's humerus forcibly up against the flexed fingers of the stabilising hand. In this way the carrying angle is reduced to a minimum, and the movement is often accompanied by a loud snap.

The extreme importance of paying due attention to this reduction of the carrying angle, when trying to secure full extension, may be seen by placing the patient on the couch with the palm of the hand facing directly upwards towards the ceiling. The carrying angle is reduced to the full extent and then, with the palm still facing up towards the ceiling, the carrying angle is gradually

increased, or apparently so, until it appears on superficial inspection that this carrying angle has been increased (roughly speaking) to a right angle If the hand is now raised to the vertical, it will be found that anything up to 90 degrees of pronation has been used to carry out the apparent increase in the carrying angle (See Figs 145, 146 and 147) Hence it comes about that, when the patient is in the recumbent position, the fact that the palm of the hand looks directly upwards is not conclusive proof that full supination has been secured, and the only way in which we can possibly be certain that extension of the elbow is full and complete is by reducing the carrying angle to the uttermost extent

FIG 143 To show how to make sure that the last few degrees of full extension of the elbow have been secured This shows an intermediate stage in the movement when the fore arm is being carried out towards full extension The carrying angle is being increased to the utmost extent (*Cf* Fig 144)

So far as the minor joint lesions of the elbow are concerned, it will therefore be seen that no one manipulation can be considered adequate or suitable as a remedy for all the conditions which may be present in this joint For one patient it may only be necessary to pull the head of the radius downwards into the orbicular ligament, for another it may be necessary to press it upwards through the orbicular ligament A third type of injury may require the pressing of the head of the radius directly backwards in full flexion, while yet another may call for the "grinding" of the beak of the olecranon into the olecranon fossa

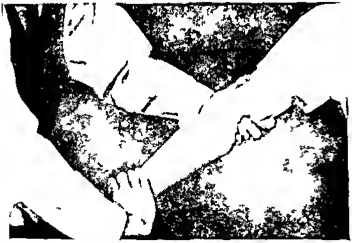

FIG 144 To show the end of the movement illustrated in Fig 143 to secure the full degree of extension of the elbow The carrying angle is now being reduced to the uttermost extent by the hand which grasps the patient's humerus

It is sometimes taught that, during the performance of manipulation for the treatment of a so-called "tennis-elbow," extension should be performed with the fore-arm held in pronation and with wrist palmar flexed and the fingers fully flexed As a means of stretching muscle fibres this particular manipulation has justification, and especially if it is desired to lay tension upon the fibres of the muscles of the extensor group, when these have sustained injury as the result of strain or over-use This, however, has nothing to do with joint manipulation, if by

FIG 145 To illustrate the beginning of the movement described in the text as increasing the carrying angle while the patient is recumbent (*Cf* Figs 146 and 147)

this we understand the remedying of some pathological condition directly associated with a joint. So far as the manipulation of the joints themselves is concerned the technique described is complete and should be entirely adequate. If the pathological condition which impeded perfect function is present in the muscles, then manipulation is only one remedy amongst many, and often not one of the most effective. It is true that the joint manipulations can all be performed with the fore-arm pronated, and often enough, no doubt, they would be successful in attaining the desired end. There is, however, no question that we can ensure the securing of the full range of extension more certainly if the fore-arm is supinated than if it is pronated.

FIG 146 To show that, when the movement begun in Fig 145 has been carried to the point where the elbow is flexed to a right angle, supination is not complete even though the palm of the hand continues to face directly upwards (See Fig 147)

FIG 147 To show the degree of pronation which is restored during the movement begun in Fig 145, when the elbow is flexed to a right angle and the humerus is internally rotated so as to bring the fore-arm to the vertical It is plain that if the humerus is externally rotated again from this position, the palm of the hand will still face directly upwards

CHAPTER X

THE SHOULDER JOINT

Anatomical Considerations

PERHAPS the question most often asked by those interested in the manipulation of joints is why manipulation of the shoulder should be so far more difficult to pull through to a satisfactory termination than that of any other joint. The answer is, first that the physiological movement of the joint has been inadequately studied, and that, therefore, the movements are too often performed with a faulty technique, and a second and almost equally important reason is that the temptation to do more than is wise seems to overcome even experienced operators when handling a shoulder, more readily than when they are manipulating other joints. Here almost more than anywhere else, it is desirable to know what is the normal range of movement for the individual. I have on several occasions been asked to see a candidate for one of the Physical Training Colleges, who has been rejected by the authorities simply because the backward movement of the shoulders was insufficient to stand the strain which would be placed upon them during the ordinary course of training, and though the tissues were perfectly normal, it has been a difficult and sometimes a long and tedious business to add the degree of elasticity necessary for the performance, when the tissues are strained, of the required movement. Any attempt to secure by sheer force a degree of movement beyond the range of the normal for the individual will only lead to disaster. A third point that is occasionally overlooked is the difference between movement of the shoulder joint and movement of the scapula. The first consists of the movement of the head of the humerus on the glenoid, the second of the scapula on the chest wall.

If we read through the usual description of the movements which are performed at the shoulder, and then compare it with the description of the movements performed at the hip joint, we are at once struck by an apparent similarity; yet the most superficial observation can only lead to the conclusion that the mechanism of the movements in the one joint is entirely different from that in the other. To begin with, there is no ligament in the shoulder joint connecting the centre of the head of the humerus with the glenoid. The ligamentum teres is absent. The next consideration is that, whereas the acetabulum is shaped so as to enclose a sphere, the glenoid is pear-shaped and relatively flat, and not only so, but the neck of the pear is set obliquely to the main part of the surface. Finally, when we compare the relative sizes of the heads of the humerus and the femur, it will be found that the articular facet on the humerus is very much bigger than the portion of the surface of the

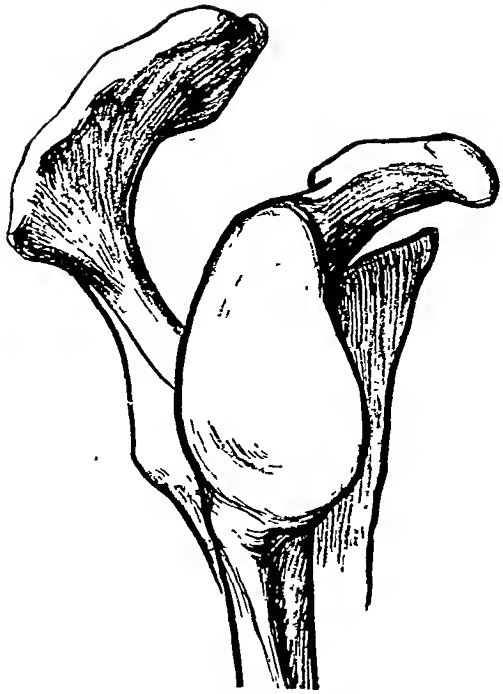

FIG 148 To show the pear-shaped contour of the glenoid

glenoid with which it articulates at any one time, whereas the head of the femur is invariably of smaller diameter than the cavity of the acetabulum into which it fits.

These very clear and simple anatomical considerations lead plainly to the conclusion stated above, that, however much the movements of the two joints may correspond with one another, the mechanism of the movements is entirely different. The explanation of the difference in movement in the two joints lies in the answer to the question: "Why is the glenoid pear-shaped?" (See Fig. 148.)

To answer this question we must first consider the nature of the physiological movement of the humerus on the glenoid, and also the reason for, and effect of, the presence of the ligamentum teres in the one joint and its absence in the other, in so far as this affects the nature of the movement of the joint. When an ordinary individual with normal movement is standing with the arm hanging loosely at the side, a palpating finger placed just external to the tip of the acromion is conscious of a hard, resistant mass directly beneath it. Then, as the arm is raised away from the side, and particularly if the deltoid is relaxed, a point is suddenly reached when this hard lump disappears and the palpating finger drops, as it were, into a pit. (See Figs. 149-152.) The mass of bone has vanished; on lowering the limb to the side it re-appears

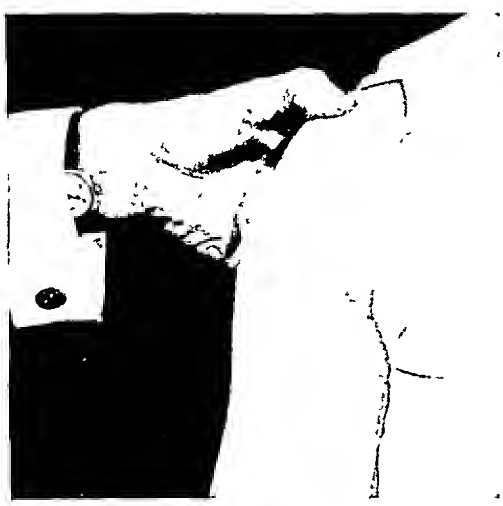

FIG 149 To show how the palpating finger placed just external to the outer side of the acromion rests upon the upper end of the humerus while the arm is hanging by the side (*Cf* Fig 150)

FIG 150 To show how the palpating finger placed as shown in Fig 149 drops into a space below the outer tip of the acromion when the arm is abducted It began to drop into the hollow when abduction had reached a little more than 30 degrees (See Figs 151 and 152)

FIG 151 The X ray photograph shows how with the arm to the side the upper end of the humerus projects well beyond the tip of the acromion to the outer side and it is plain that if the arm were abducted without any slipping downwards of the head of the bone on the glenoid the soft structures between the head of the humerus and the acromion must be nipped The long flat surface shown on the head of the bone changes its plane from that of a line sloping slightly downwards and outwards to one that slopes downwards and inwards when the movement of abduction has not advanced very far (See Fig 152)

FIG 151

FIG 152

FIG 152 In this photograph the head of the humerus has moved through roughly half the full movement of abduction Note that the flattened surface of the upper end of the humerus is now oblique to an extent that it is parallel with the outer end of the clavicle and that the prominence of the point of the shoulder seen in Fig 151 has already begun to vanish underneath the acromion without materially altering the space between the two bones The other point which shows very distinctly is the difference in shape of the bony contour of the axilla In Fig 151 the arch is almost Gothic in Fig 152 it is more of a flattened Norman type Finally there is quite a large part of the articular surface no longer in contact with the glenoid whereas in Fig 151 the glenoid projects below the lowest part of this articular cartilage

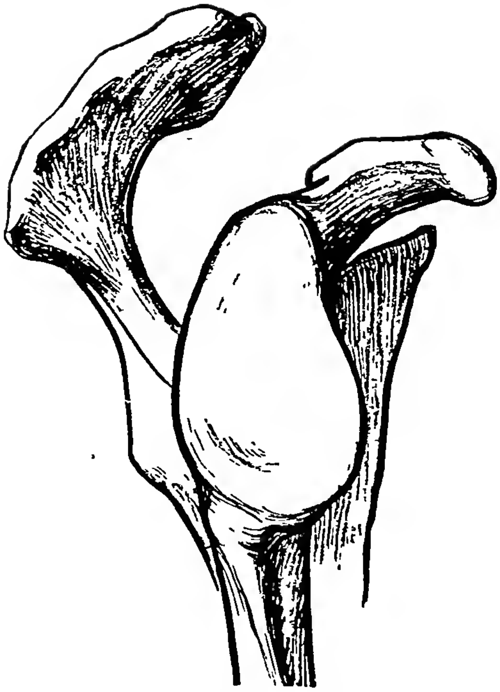

FIG 148 To show the pear-shaped contour of the glenoid

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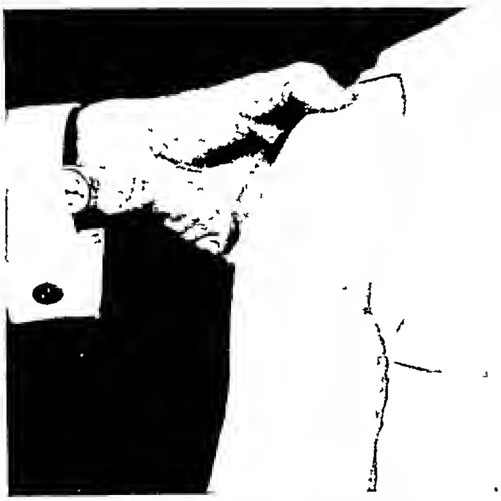

FIG 149 To show how the palpating finger placed just external to the outer side of the acromion rests upon the upper end of the humerus while the arm is hanging by the side (*Cf* Fig 150)

FIG 150 To show how the palpating finger placed as shown in Fig 149 drops into a space below the outer tip of the acromion when the arm is abducted It began to drop into the hollow when abduction had reached a little more than 30 degrees (See Figs 151 and 152)

Where there is some impediment to the gliding movement of the head of the humerus on the glenoid what must inevitably happen, if the two movements in question are performed, is plain In abduction the upper end of the humerus it if cannot slip downwards, will encounter the lower surface of the acromion with the inevitable result if force is exerted that the soft structures viz, the two synovial surfaces which line the bursal space under the acromion, will be nipped between the two bones and an acute bursitis will be set up (See Figs 153-157) This is a matter of very serious damage which is often far more difficult to remedy than the original trouble for which the manipulation was performed The same applies to the performance of forward flexion if the head of the humerus does not slip downwards and backwards on the surface of the glenoid In other words, if the function of a shoulder joint is not perfect, no attempt should ever be made to put it through the full range of movement until we have made absolutely certain that the head of the humerus is free to glide without impediment on the surface of the glenoid in the directions mentioned This has a direct bearing on the order in which the various movements of manipulation should be performed it is essential to ensure that the structures at the back of the joint are free before anything else is attempted

FIG 156 X ray photograph to show the normal movement of the head of the humerus on the glenoid during abduction of the arm for comparison with Fig 157 in which the head of the humerus is prevented from sinking downwards on the glenoid by pressure upwards on the flexed elbow

FIG 157 Note that if abduction of the shoulder is now increased the upper end of the humerus must impinge on the lower surface of the acromion—the head of the humerus is pushed up by pressure on the olecranon (*Cf* Fig 152 in which the olecranon is allowed to hang freely)

Further anatomical considerations are relatively of small importance

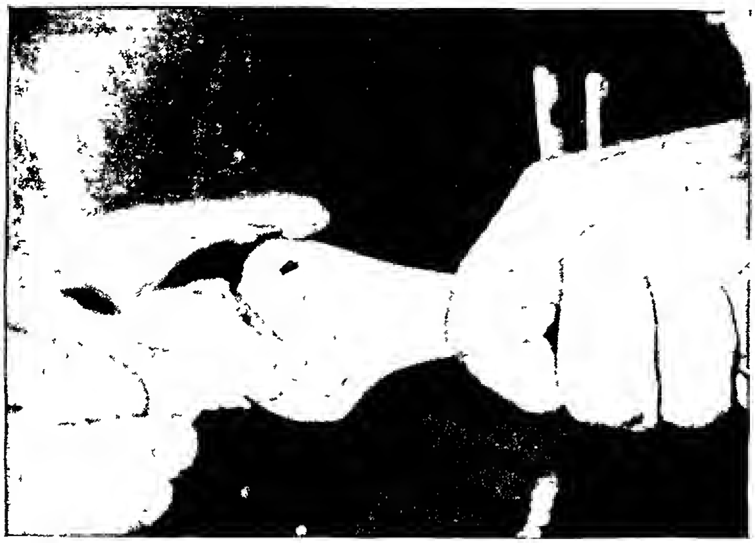

FIG 153 To show the normal movement of abduction of the shoulder joint, and how the head of the humerus drops downward in the glenoid to allow the upper end of the bone to glide under the acromion without impediment (*Cf* Figs 154 to 157)

apparently quite suddenly under the finger. If now the palpating finger is placed just in front of the outer end of the acromion, a similar mass of bone is encountered. On forward flexion this again suddenly disappears from underneath the finger when a certain degree of movement has been reached, and re-appears during the return journey. These two observations can mean only one thing, namely, that, during the ordinary physiological movement of the joint, the head of the humerus drops downwards in the glenoid in abduction, and downwards and backwards in forward flexion. It is in order that the head of the bone may perform these gliding movements on the scapula that the glenoid is shaped as it is. Unless this is kept in mind any forced movement of the shoulder is liable to be performed without due regard to the physiological laws of movement, and disaster will follow.

FIG 154 To show how the soft structures underneath the acromion are nipped between this overhanging edge of bone and the upper end of the humerus, if the latter does not glide downwards on the surface of the glenoid during abduction (*Cf* Figs 155 to 157)

FIG 155 To show the position of the head of the humerus in relation to the glenoid when the former is lowered from the abducted position shown in Fig 153 till it hangs vertically, but without performing any gliding movement of the humeral head on the glenoid

Fig 159 This shows the normal appearance of an X ray photograph of the shoulder taken as nearly in the normal antero posterior position as possible It is noticeable that the head of the humerus overlaps the posterior part of the glenoid to a material extent The shadow shown by the fingers in the lower part of the photograph indicates the highest level at which they could be inserted into the axilla (See Fig 160)

Fig 159

Fig 160 The elbow has been stabilised and the hand in the axilla is now pulling the upper end of the humerus directly away from the side of the patient The contour of the shadows thrown by the scapula are almost identical with those shown in Fig 159 and yet the upper end of the humerus has moved so far outwards that not only is the overlap seen in Fig 159 removed altogether but a definite space has been revealed between the shadows thrown by the two bones

Fig 160

from the point of view of manipulation. The articular surface on the head of the humerus is spherical for all practical purposes, though the sphere is less than half complete. To the outer side of the articular surface, and extending somewhat forwards, the great tuberosity juts outwards at a somewhat lower level than the highest part of the articular facet. It is limited in front by the groove for the biceps tendon, which, if prolonged over the articular surface, would divide it into two almost equal parts (see Fig. 158), the inner being slightly the longer of the two.

The depth of the very shallow hollow on the glenoid is increased by the glenoidal labrum which forms a fibro-cartilaginous ring attached to its circumference. Even when this is taken into account, the socket on to which the head of the humerus fits is a very shallow one. Also the whole surface of the glenoid can at one time cover only a relatively small part of the articular surface on the head of the humerus. Yet it is the pear-shaped prolongation that proves that the description of the joint as a true ball-and-socket joint is incorrect. To use this description is to ignore the gliding movement of the head of the humerus on the glenoid during ordinary physiological motion.

FIG 158 View of the upper end of the humerus to show that, if the tendon of the biceps were continued above the top of the bicipital groove and was then passed over the head of the bone in a straight line, it would divide the head of the bone into two almost symmetrical portions Note also how the great tuberosity protrudes very far beyond the level of the edge of the articular surface

The ligaments of the shoulder joint play an insignificant part when considered solely in the light of their effect on manipulative treatment. The stability of this joint, more than any other, depends on the control of the muscles that govern the movements of the joint rather than on ligamentary control. One point in particular is, however, worthy of emphasis. This is that, when the arm is hanging at the side, the capsular ligament must rest in folds on the under-surface of the joint, since there must be enough slack material here to allow for enormous range of movement in the joint without stretching. Thus it comes about that, if an inflammatory condition within the joint has been present while the arm is allowed to hang by the side, the surfaces of the capsule must tend to become matted together; the natural spread of the capsule is thereby lost, and, if the full range of movement is enforced in all directions, the capsule is almost certain to be injured severely.

Estimation of Normal Movement

The head of the humerus can be pushed upwards on the glenoid, forwards, backwards and downwards, and, finally, can be dragged away from the glenoid. This wide variety of movement is due to the fact that the stability of the joint is dependent on muscular action far more than on ligamentous control. Hence it comes about that the movement of dragging the head of the humerus directly away from the glenoid causes a very real separation of the

a twinge of pain Still, the difficulty of examining the movement of the head of the humerus on the glenoid is very greatly enhanced if the deltoid is not in a state of complete relaxation In the recumbent position this difficulty is minimised

As has already been mentioned, it is more important when examining a shoulder joint than when examining most other joints to ascertain what is the normal range of movement of the individual in question Having ascertained this, one hand is used to support the whole of the weight of the limb in the manner shown in Figs 161 and 162 The other hand should rest upon the point of the shoulder in such a way as to be able to detect whether the gliding movement of the head on the glenoid takes place or not, and whether the upper end of the bone approximates to the acromion instead of dropping away from it The humerus is first led forward into forward flexion until the limit

Fig 163 To show how the range of forward flexion of the shoulder can be compared with that of the sound side while recumbent

Fig 164 To show the examination of the movement of external rotation when standing for comparison with the sound side

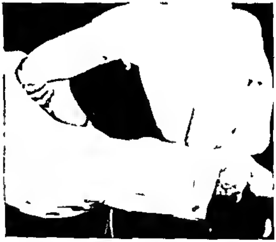

Fig 165 To show how the movement of extension backwards of the shoulder while the elbow is bent may be performed with the patient upright The main stabilising control is exercised by the full movement of the shoulder on the sound side

of painless movement is reached, then, using the same grip, it is led into backward flexion, and, thirdly, the arm is again placed against the side and external rotation is examined, preferably with the same grip

Sometimes it is desirable to compare directly the movements on the

FIG. 161. To show the grip for examining the movement of the head of the humerus on the glenoid while the patient is in the upright position. The examination in the supine position is shown in Fig. 162.

two joint surfaces, as is shown in Figs. 159 and 160. Often enough, when for any reason the arm has been allowed to hang inert by the side, the deltoid, partly no doubt on account of increasing weakness of the power of its fibres, and partly because it is physiologically very difficult for it to remain constantly in the same degree of tone for an indefinite period, will allow the head of the humerus to drop downwards on the surface of the glenoid. It may possibly be held that this is not an abnormal movement; but we must remember that there are no supporting ligaments which are capable of preventing a very considerable degree of dropping. Then the convex surface of the head of the bone will ultimately come to rest against the, comparatively speaking, sharp surface of the edge of the glenoid, rather than resting, as it ought to do, on the smooth part of the articular surface. The result of this is a definite irritation of the nerve supply of the joint at the pressure points, and is one of the not uncommon causes of that radiating pain throughout the arm, which is commonly referred to—mistakenly—as brachial neuritis. It is amazing to find the extent to which pain can radiate down the arm from this very simple cause. It frequently happens that merely pushing the head of the humerus upwards on the glenoid, and giving support to the olecranon for a short time, while the deltoid recovers its tone, will bring relief to a victim of the most severe so-called "brachial neuritis," even when it is of very long standing.

FIG 162. To show the grip for examining the movement of the head of the humerus on the glenoid when the patient is recumbent. The hand over the head of the bone can detect whether the upper end of the humerus is gliding downwards sufficiently to avoid contact with the acromion

The technique of manipulation varies so much according to whether the patient is in the vertical or the horizontal position that it is wise to consider the movements quite separately according to which of those two positions is adopted. When the patient is in the vertical it is not so easy to establish whether the head of the humerus is gliding freely on the surface of the glenoid as when the patient is recumbent. This is due to the difficulty most patients experience in relaxing completely while a movement is performed for them, particularly if the movement is liable to cause

a twinge of pain Still the difficulty of examining the movement of the head of the humerus on the glenoid is very greatly enhanced if the deltoid is not in a state of complete relaxation In the recumbent position this difficulty is minimised

As has already been mentioned, it is more important when examining a shoulder joint than when examining most other joints to ascertain what is the normal range of movement of the individual in question Having ascertained this, one hand is used to support the whole of the weight of the limb in the manner shown in Figs 161 and 162 The other hand should rest upon the point of the shoulder in such a way as to be able to detect whether the gliding movement of the head on the glenoid takes place or not, and whether the upper end of the bone approximates to the acromion instead of dropping away from it The humerus is first led forward into forward flexion until the limit

Fig 163 To show how the range of forward flexion of the shoulder can be compared with that of the sound side while recumbent

Fig 164 To show the examination of the movement of external rotation when standing for comparison with the sound side

Fig 165 To show how the movement of extension backwards of the shoulder while the elbow is bent may be performed with the patient upright The main stabilising control is exercised by the full movement of the shoulder on the sound side

of painless movement is reached, then, using the same grip, it is led into backward flexion, and, thirdly, the arm is again placed against the side and external rotation is examined, preferably with the same grip

Sometimes it is desirable to compare directly the movements on the

FIG 166 To show the same movement as illustrated in Fig 165, but now the elbow is straight and the fore-arm supinated so as to lay traction on the tendon of the biceps in the bicipital groove

two sides instead of relying on memory to remind us of the range of movement on the sound side. Assisted forward flexion and abduction can only be examined with difficulty in this way in the upright position, though examination is easy enough when the patient is recumbent. (See Fig. 163.) It is, however, possible to examine the external rotation while upright, but the grip will have to be altered. (See Fig. 164.) The arms should then be carried in front of the body into adduction, and a useful guide is to discover how far the patient can reach round towards the back of the neck on the opposite side, but it must be remembered that this involves a wide range of movement of the scapula as well as of the shoulder.

Then the examiner must pass round behind the patient, and backward flexion is examined, first with the elbow bent and then with the elbow straight and the fore-arm in supination. (See Figs. 165 and 166.) The importance of this alteration in technique is to discover whether the biceps tendon is playing a part in any limitation which may be present. If the movement is apparently free while the elbow is flexed, but gives pain when the elbow is extended and the fore-arm supinated, we have almost certain proof that the trouble lies, in part at any rate, within the biceps tendon sheath.

Finally, the hand is led round towards the back and the elbow is flexed

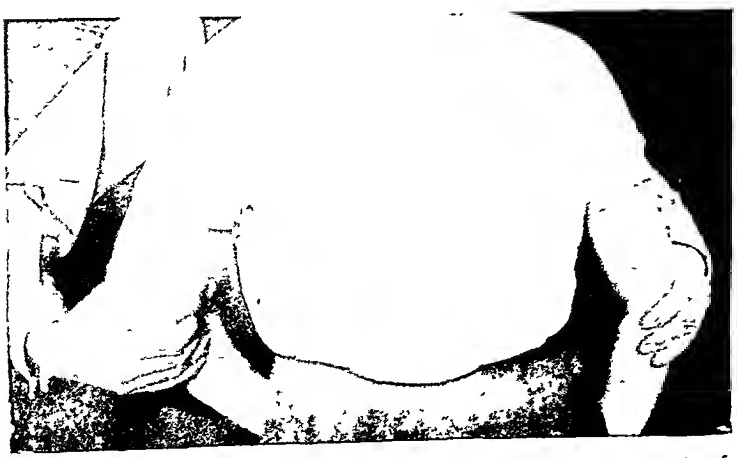

FIG 167 To show the examination of the movement of internal rotation of the shoulder so as to try to distinguish between limitation of backward flexion and limitation of internal rotation

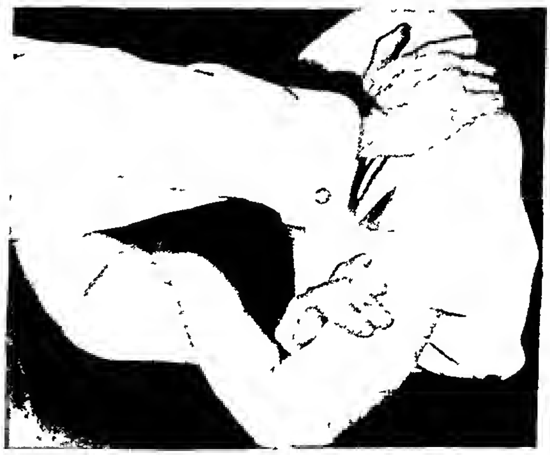

FIG 168 To show how the movement of external rotation of the shoulder may be increased with the patient upright (*Cf.* also Fig 188, p 141)

so as to carry the hand as far as possible upward towards the shoulder-blade of the opposite side (See Fig 167 and Fig 188, p 141) It is important to note, should this movement appear to be limited, that the limitation may be due to inadequate movement of the body of the scapula It frequently happens that, when freedom of mobility has been restored to this bone, a very definite increase of movement upwards behind the back may be secured It is important also, should the movement be limited to try to discover whether the limitation is due to lack of internal rotation or to lack of backward flexion, or to both This can often be ascertained by supporting the weight of the fore-arm while backward flexion is performed, and then by observing the level on the back to which the back of the fore-arm, not the hand, can be raised (See Figs 167 and 168, p 130) Sometimes it is apparent

FIG 169 To show the grip for pushing the head of the humerus upwards on the glenoid while the patient is upright This shows how the mobilising force is derived from the trunk muscles Not only is the elevating force thus applied but a small range of flexion and extension is added at the same time (*Cf* Figs 170 and 171) Note that the trunk of the manipulator is vertical

FIG 170 To show the end of the movement begun in Fig 169 when a small degree of forward flexion is added by side bending of the manipulator's trunk Note that the trunk is leaning well backward when compared with the position shown in Fig 169 in order to secure the upward pressure on the olecranon

that the point of the elbow cannot be carried far enough back to allow adequate flexion of the elbow, while at other times it may be found that the back of the fore-arm is, as it were, glued on to the small of the back, and that any attempt to pull it away from this position causes undue pain, although no attempt is made to increase the degree of rotation This part of the examination is usually more easily made in the vertical than in the recumbent position If recumbent the patient must be placed in the side-lying position

Movements Not Under Voluntary Control

1 Pushing the Head of the Humerus Upwards on the Glenoid

A In the Vertical Position

In order to push the head upwards in the glenoid, when standing, a stabilising hand must be placed over the top of the patient's

FIG 171 The same as Fig 170, except that the arm is now carried backwards by side-bending of the manipulator's trunk in the opposite direction The patient's elbow is pressed firmly against the trunk throughout the movement

shoulder so as to ensure that the contour of the line which follows the margin of the trapezius never alters. In other words, the function of this hand is effectively to prevent any elevation at all of clavicle and scapula. The other hand, in this instance a second stabilising hand, grasps the patient's elbow, the palm resting under the olecranon, and the patient's fore-arm rests upon that of the manipulator. (See Figs. 169, 170 and 171.) This hand then presses the elbow firmly up against the front of the chest of the manipulator, and the mobilising force is derived solely through the muscles of the trunk, which passes from a slight degree of flexion into full extension. A very considerable force may be thus exerted and this technique is not only useful in restoring movement, but it will also often help to solve the knotty problem whether the joint is in a fit state to manipulate or not. If there is active inflammation within the joint, this movement is always decidedly painful; if it is safe to proceed, it is painless.

B. Recumbent.

To press the head of the humerus upwards on the glenoid when lying, the patient's fore-arm is bent to a right angle and is raised forward into a few degrees of forward flexion. The stabilising hand is then placed between the couch and the top of the patient's shoulder so that when the wrist is fully dorsi-flexed the fore-arm shall rest vertically with regard to the clavicle. (See Fig. 172.) The mobilising hand is then placed over the olecranon and the sternum of the manipulator is pressed down upon this hand. The mobilising force is exerted by allowing the weight of the manipulator's body to fall forward so as to exert pressure, through the mobilising hand, upwards in the long axis of the humerus. The movement may be made a little more effective by swaying the body slightly, so as to lead the humerus to and fro through a few degrees of forward flexion and back again. There is no leverage.

FIG 172 To show the grip for pushing the head of the humerus upwards on the glenoid while the patient is recumbent

2 Pushing the Head of the Humerus Forward on the Glenoid

A In the Vertical Position

In order to perform the forward movement of the head of the humerus upon the glenoid, the stabilising hand assumes exactly the same grip as the second of the two stabilising hands in the former movement except that now the web of the thumb is placed horizontally across the front of the patient's arm (See Fig 173) The mobilising hand is then placed over the back of the neck of the humerus, the fore-arm is moved up till the wrist is in full dorsi-flexion and the fore-arm bones are exactly vertical to the humerus Then a forward thrust is given from the shoulder of the operator Fingers, wrist and elbow should play no part There is, fortunately, no need as a general rule to make use of this particular movement, it is the most difficult of all to control, as, in "taking up the slack," we have to arrange matters so that the scapula is fixed before the mobilising force is impressed To stabilise the scapula in this position is by no means easy

FIG 173 To show the grip for pressing the head of the humerus forward on the glenoid the patient being upright The patient's arm is shown in a position of greater abduction than is used in practice but this is for the sake of clearness of view Note also that the patient's elbow is fixed firmly to the side of the manipulator's trunk

B In the Recumbent Position

When recumbent it is well-nigh impossible to pull the head of the humerus forward efficiently, though to a certain extent this can be done by fixing the back of the patient's humerus to the couch with the stabilising hand while the mobilising hand grasps the upper part of the patient's humerus from the inner side The difficulty of this movement is to stabilise the scapula so that a large amount of the mobilising force may not be expended upon moving this bone In order to overcome the difficulty the patient's elbow can be fixed to the couch by the gluteal region of the manipulator, and then a hand is left free for stabilising the scapula by placing it with the wrist fully dorsi-flexed over the acromion and outer end of the clavicle The mobilising hand then grips the back of the

FIG 174 To show the grip for pulling the head of the humerus forwards on the glenoid the patient being recumbent Note the method of stabilising the patient's elbow by leaning the thigh over it

FIG 175 General view of the method of securing full stabilisation while pressing the head of the humerus backwards on the glenoid, the patient being upright

patient's arm as near the axilla as possible and pulls directly forward away from the couch. There is no leverage. (See Fig. 174.)

3. Pushing the Head of the Humerus Backwards on the Glenoid

A. In the Vertical Position.

In order to press the head of the humerus backwards on the glenoid the position of the two hands must be reversed from that adopted when pushing the head forwards. This is one of the most important movements of all, and to make it effective steps must be taken to see that the whole of the patient's trunk is adequately supported. With this in view, the operator stands a shade behind the patient and places the foremost foot behind the feet of the patient. He then arranges that the back of the patient's thigh should rest against the outer side of his own thigh, and in a similar manner the gluteal region and back of the patient's trunk are fixed against the outer side of the upper part of his thigh and the lower part of his own trunk. (See Figs. 175 and 176.) The stabilising hand is then placed over the back of the scapula with the fingers vertically upwards and the base of the hand resting just below the level of the spine of the scapula. The fingers are then allowed to drop over the upper part of the shoulder, and the elbow is raised until the stabilising fore-arm is vertical to the scapula with the wrist fully dorsi-flexed. Now the patient's arm is carried into a slight degree of abduction so as to rest against the side of the manipulator's trunk. The fore-arm of the mobilising limb supports the patient's fore-arm; the hand is placed directly over the front of the bone as near the axilla as circumstances will allow. The elbow is then raised till the hand is fully dorsi-flexed, and it is essential that the two fore-arms of the operator should now be exactly parallel with one another. To secure the accurate position of the hands is comparatively simple, but the stabilising forces need careful adjustment, as practically the whole of the trunk of

FIG 176 To show a close-up view of the grip for pressing the head of the humerus backwards on the glenoid, the patient being upright The function of the two hands is reversed when compared with the movement shown in Fig 173 Note how the patient's elbow is rigidly fixed against the side of the manipulator's body, while the stabilising hand over the back part of the patient's scapula prevents this from any backward movement

both parties is engaged in the stabilising process The mobilising hand in front of the humerus is now in a position to "take up the slack," and, when this is done, to give a final impressed force which will carry the head of the bone directly backwards on the glenoid

B In the Recumbent Position

Pressing the head of the humerus backward on the glenoid, when recumbent, calls for the same stabilising grip as we used in the standing position, *i e*, the patient's elbow and the operator's elbow are both held at a right angle, the fore-arm of the patient resting loosely upon that of the operator (See Fig 177) The stabilising hand then fixes the patient's elbow against the chest of the operator or against, or upon, his knee, which is flexed so as to kneel upon the side of the couch The thigh must be oblique The mobilising hand is then placed high up on the neck of the humerus with the fingers extending upwards over the deltoid, the wrist being fully dorsi-flexed, and a downward thrust at right angles to the shaft is exerted in an antero-posterior direction No leverage is exerted, and so a considerable amount of force may be expended By raising the support of the patient's fore-arm the mobilising force may be applied through various stages of forward flexion, but, needless to say, the direction of the mobilising force must always remain at right angles to the shaft of the humerus

FIG 177 To show the grip for pushing the head of the humerus backwards on the glenoid while the patient is recumbent The manipulator kneels on the couch with his right knee on the couch and the back of the patient's arm rests upon its anterior surface

There are some who teach that manipulation of the shoulder under an anæsthetic is best carried out with the patient seated in a chair In this position however, it is very difficult to perform the movement we are now considering at all, and to perform it efficiently is impossible Yet it is the one movement, which, above all others, it is essential to free before performing forward flexion or abduction In the standing position as has already been shown, the movement can be performed with moderate efficiency, but even so the method is not so satisfactory as when the patient is recumbent

4 Pulling the Head of the Humerus away from the Glenoid

A In the Vertical

In order to pull the head of the humerus away from the glenoid, in the upright position, the stabilising hand again assumes much the same grip as when pressing the head upwards in the glenoid, but now the mobilising hand is placed against the inner side of the limb as near to the axilla as circumstances allow (See Fig 178) The patient's elbow is stabilised by securing

FIG 175. General view of the method of securing full stabilisation while pressing the head of the humerus backwards on the glenoid, the patient being upright

patient's arm as near the axilla as possible and pulls directly forward away from the couch. There is no leverage. (See Fig. 174.)

3. Pushing the Head of the Humerus Backwards on the Glenoid

A. In the Vertical Position.

In order to press the head of the humerus backwards on the glenoid the position of the two hands must be reversed from that adopted when pushing the head forwards. This is one of the most important movements of all, and to make it effective steps must be taken to see that the whole of the patient's trunk is adequately supported. With this in view, the operator stands a shade behind the patient and places the foremost foot behind the feet of the patient. He then arranges that the back of the patient's thigh should rest against the outer side of his own thigh, and in a similar manner the gluteal region and back of the patient's trunk are fixed against the outer side of the upper part of his thigh and the lower part of his own trunk. (See Figs. 175 and 176.) The stabilising hand is then placed over the back of the scapula with the fingers vertically upwards and the base of the hand resting just below the level of the spine of the scapula. The fingers are then allowed to drop over the upper part of the shoulder, and the elbow is raised until the stabilising fore-arm is vertical to the scapula with the wrist fully dorsi-flexed. Now the patient's arm is carried into a slight degree of abduction so as to rest against the side of the manipulator's trunk. The fore-arm of the mobilising limb supports the patient's fore-arm; the hand is placed directly over the front of the bone as near the axilla as circumstances will allow. The elbow is then raised till the hand is fully dorsi-flexed, and it is essential that the two fore-arms of the operator should now be exactly parallel with one another. To secure the accurate position of the hands is comparatively simple, but the stabilising forces need careful adjustment, as practically the whole of the trunk of

FIG 176 To show a close-up view of the grip for pressing the head of the humerus backwards on the glenoid, the patient being upright The function of the two hands is reversed when compared with the movement shown in Fig 173 Note how the patient's elbow is rigidly fixed against the side of the manipulator's body, while the stabilising hand over the back part of the patient's scapula prevents this from any backward movement

technique also has the advantage that no strain whatever is placed upon the elbow. The arm is raised with the patient recumbent into the vertical as far as it will go in complete comfort. If dealing with the patient's left limb, the back of the arm is placed upon the top of the right shoulder of the operator. The two hands are then clasped round the inner side of the upper part of the patient's arm as near the axilla as possible. The shoulder acts as a stabilising force while the two hands pull the upper end of the humerus directly away from the patient's glenoid, then the hands stabilise, acting as a fulcrum, while the operator's shoulder presses the lower end of the humerus towards the patient's trunk. The leverage is comparatively small, but the amount of force that can be exerted is very considerable; moreover it is of considerable service that the traction can be applied not only with the patient's arm in the vertical, but with the humerus in more than one position of abduction and forward flexion. There is nothing to be gained by attempting to perform the movement in any degree of abduction beyond 45 degrees. (See Fig. 180 and compare with Fig. 185.)

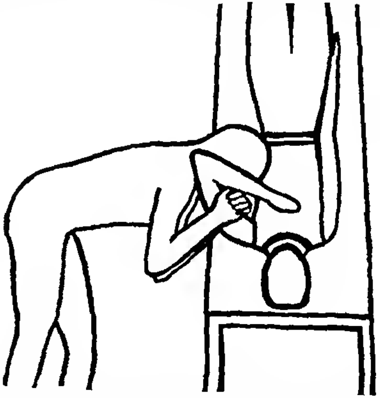

FIG. 180. To show an alternative method of pulling the head of the humerus away from the glenoid with the patient recumbent. The final mobilising force is movement of the shoulder. (Cf. Fig. 185, p. 140.)

5. Pressing the Head of the Humerus Downwards on the Glenoid

A. In the Vertical

Pulling the head of the humerus downwards on the glenoid by direct traction is a clumsy affair in the vertical, as it can only be done while the patient is standing with the arm hanging freely at the side. It is very difficult indeed in this position to apply any stabilising force, and we have to rely entirely on the patient's muscles to maintain the trunk rigidly in the upright position. There is, however, another way in which, to a certain extent, the head of the humerus can be pushed downwards on the glenoid. The stabilising hand and arm adopt precisely the same grip as that which was used in pressing the head upward in the glenoid. The patient's arm is then carried into abduction and the base of the mobilising hand is placed just above the insertion of the deltoid. (See Fig. 181.) The fore-arm of the mobilising hand is then raised till the wrist is fully dorsi-flexed, and the mobilising force is exerted at direct right angles to the humerus. A word of caution is here necessary. It is never safe to perform this movement unless the stabilising hand has a completely safe and rigid anchorage;

it against the side of the chest wall over the lower ribs as near the mid-axillary line as possible. The elbow of the mobilising hand is raised till the wrist is fully dorsi-flexed, and again the mobilising force is exerted at right angles to the shaft of the humerus. The object is to carry the head of the bone directly outwards from the trunk, and neither upward nor downward at the same time. The mobilising force, as before, comes from the shoulder; the elbow, wrist and fingers play no part.

B. Recumbent.

In order to push the head of the humerus, by direct pressure, away from the glenoid it is necessary to hold the arm away from the patient's

FIG 178 To show the grip for pulling the head of the humerus away from the glenoid, the patient being upright The photographic difficulties made it impossible to show the back of the patient's fore-arm resting against the side of the chest of the operator, and, before any mobilising force is impressed, the operator would need to pass round towards the front aspect of the patient till the two fore-arms, here shown facing the camera, were resting in front of the patient's body

FIG 179 To show how the head of the humerus may be dragged away from the glenoid, the patient being recumbent Note the dorsi-flexion of the mobilising hand and that the corresponding fore-arm is pressing outwards impressing a force vertical to the inner side of the shaft of the humerus as near to the upper end of the bone as the axillary walls will allow Even so the force will be exerted at about the level of the insertion of the deltoid

side until it rests in a few degrees of abduction. The stabilising hand then fixes the back of the patient's fore-arm on to the couch, or on to the flexed thigh as before. (See Fig. 179.) Next, the mobilising hand is then placed as near up towards the axilla as possible, and the wrist is dorsi-flexed to a right angle. The mobilising force is applied by the shoulder muscles at right angles to the inner side of the upper end of the patient's humerus. Fingers, wrist and elbow take no part in the movement. There is no leverage of importance.

C. Alternative Method for Pulling the Head of the Humerus away from the Glenoid (Recumbent).

If coarse adhesions are limiting movement, a very considerable force—under perfect control—may be required to restore mobility. The following

Fig 183 To show how traction may be applied to the shoulder joint in abduction while the patient is recumbent The head of the humerus can thus be pulled away from the glenoid In the position shown the fibres of all the shoulder girdle muscles are parallel with one another forming as it were a cone shaped mass the apex of the cone being approximately the insertion of the deltoid The patient grasps the far side of the couch with the free hand and the manipulator may place his foot up against the side of the table in order to reinforce the strength of the pull

technique is very similar to that in the vertical The patient's arm is either placed in a slight degree of abduction on the couch (see Fig 184), or it may rest upon the manipulator's flexed thigh, the knee resting on the couch as in Fig 179 The stabilising hand then grasps the inner side of the patient's elbow and the wrist is dorsi-flexed so as to bring the fore-arm to a right angle with the humerus The mobilising force is now exerted by placing the hand near the upper part of the humerus over the deltoid, the wrist is fully dorsi-flexed and the mobilising force is exerted by the shoulder muscles along the fore-arm at right angles to the shaft of the humerus Under no circumstances should this movement be performed with the patient's arm abducted beyond 45 degrees

C *Alternative Method for Pulling the Head of the Humerus Downward on the Glenoid (Recumbent)*

With the patient still recumbent, the arm is raised towards the vertical as far as it will go with the elbow bent to any suitable angle and in slight abduction When dealing with the patient's left shoulder, the operator's left shoulder is placed on the back of the patient's arm while the two hands are clasped round the front of the arm as far up towards the axilla as is possible The operator's left shoulder acts as a stabilising force while the two hands exert a mobilising force to drag the head of the bone directly downwards on the glenoid When the limit is reached, the hands stabilise and act as a fulcrum while the shoulder acts as the mobilising force A very considerable amount of force can be exerted in complete safety, unless there is some condition of the glenoid which has rendered the patient liable to sub-glenoid dislocation Even should this condition be present, the chance of the head of the bone slipping out of the glenoid is very

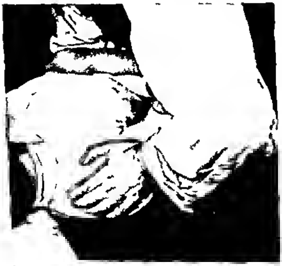

Fig 184 To show the grip for pushing the head of the humerus downwards on the glenoid while the patient is recumbent

FIG 181 To show the grip for pressing the head of the humerus downwards on the glenoid, the patient being upright Note that the degree of abduction is fixed rigidly by pressing the patient's elbow firmly against the chest of the operator

then, even granted this, it is never safe to perform the movement when abduction is advanced beyond 45 degrees. There is a very real danger of dislocating the joint if these two precautions are disregarded. To secure the rigid anchorage the patient's elbow must be fixed firmly against the manipulator's chest so that under no circumstances can it move, or be moved, into further abduction when the mobilising force is applied.

B. Recumbent.

We have already seen the method by which the head of the humerus may be pulled downward on the glenoid by direct traction in the vertical position is unsatisfactory; but in the recumbent position this is not so. It is indeed, a very simple matter to pull the head of the humerus downward on the glenoid when the patient is recumbent. The mobilising hand takes exactly the same grip as it does when performing traction on the carpus or radio-ulnar joints. (See Fig. 87, p. 90.) The stabilising hand is placed on the side of the chest wall as near the axilla as possible, the thumb being fully extended so as to steady the axillary border of the scapula. The wrist of this hand is now fully dorsi-flexed and the elbow fully extended. The arm is carried into a few degrees of abduction by the mobilising hand, and traction is then applied in the long axis of the humerus—the elbow, of course, being fully extended. (Fig. 182.) It is often desirable to lead the arm on the injured side outwards into abduction as far as it will go while still applying the traction, and it may be found that a far wider range of movement can be restored in this way than if traction is not applied. There is no leverage provided the head of the bone slides under the acromion without impinging upon it. Alternatively both hands may be used to apply traction, and fixation is then secured by the patient's grasp of the couch (Fig. 183).

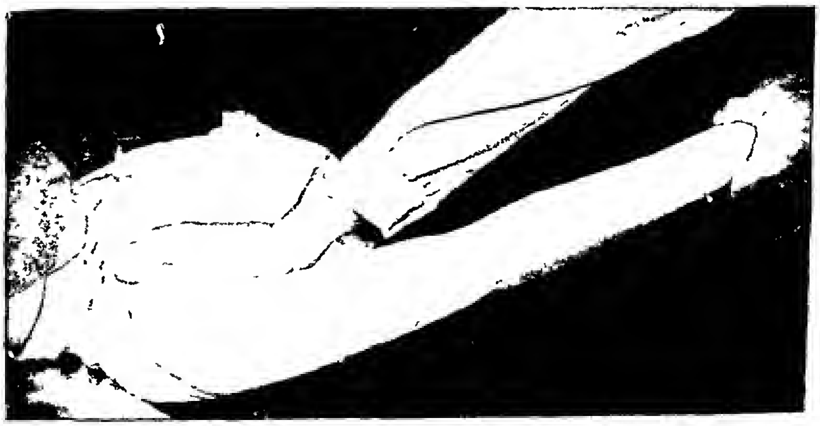

FIG 182 To show how the head of the humerus may be pulled downwards on the surface of the glenoid, the patient being recumbent It is plain that a corresponding grip is impossible while the patient is standing, and would be difficult when seated The mobilising force is trunk rotation

To press, as distinct from to pull, the head of the humerus downward in the recumbent position, the

Abduction

To perform abduction with the patient upright a grip similar to that chosen for pushing the head of the humerus upward in the glenoid is adopted, with this difference, that the stabilising hand now rests over the upper end of the bone in such a position that the fingers lie over the front of it and facing directly antero-posteriorly (See Fig 187) The hand is placed in this position not only so as to detect (and, if necessary, prevent) any upward movement of the scapula but also to detect whether the upper end of the humerus is slipping freely downwards on the glenoid If not, it should be the function of these fingers to assist the movement Still more important, however, is the fact that the head cannot slip downwards in a normal way if there is the faintest tendency for it to slip forward at the same time Therefore these guiding fingers should also ensure that the head is kept well backward on the glenoid while the movement is being performed The mobilising hand is now no longer glued to the operator's trunk, it must be free to move in all directions If doubt arises as to whether relaxation on the part of the patient is reasonably complete, this can be tested by a slight movement of the examiner's elbow, which should cause a corresponding movement in the elbow of the patient If the patient's elbow does not move freely, then it is a reasonable assumption that relaxation of the shoulder muscles is not present

Fig 187 To show how abduction of the shoulder may be performed with the patient seated This shows the limit of the movement The patient's arm is slightly above the horizontal

Fig 188 To show how internal rotation of the shoulder may be coaxed through a further range in the upright position In the lower part of the photograph the patient's wrist is carried backwards away from the back of the patient pure flexion of the elbow brings it again into contact with the back only at a higher level It is necessary not only to increase the amount of backward flexion of the humerus but some internal rotation must be added as well (*Cf* also Fig 168 p 130)

Forward Flexion

The rules governing forward movement should be identical with the above, but it is impossible to insist too strongly on the point that under no circumstances should abduction or forward flexion be forced unless the fingers over the top of

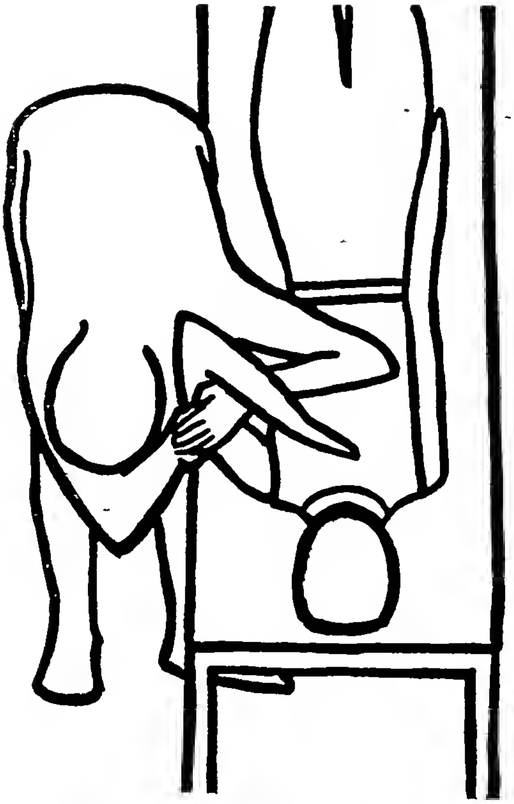

FIG 185 To show an alternative method of pulling the head of the humerus downwards in the glenoid for comparison with Fig 180 Note that in both instances the operator's hands should be as close to the axilla as possible and not in the positions shown for the sake of clearness

small, largely because it is quite possible to exert a certain amount of backward pressure while the hands resist the mobilising force. (See Fig. 185.) This manipulation corresponds very closely to the pulling of the head of the humerus away from the glenoid, the only difference being that with this movement the left shoulder is used as a stabilising force while taking up the slack and then exerts the mobilising force, whereas in the pulling of the head of the humerus away from the glenoid the right shoulder is used. In the first of these two manipulations also (Fig. 185) the hands are clasped over the front of the upper end of the humerus, in the second they are clasped over the inner side (Fig. 180). (*Cf.* Figs. 180, p. 137, and 185.)

Movements Under Voluntary Control

Adduction

The first movement to secure, despite teaching to the contrary, is that of adduction across the front of the body. If there is impediment to this movement in the back of the joint, it is impossible for the head of the humerus to glide freely backwards on the glenoid, and so the next two movements become impossible through the full range. The hand of the patient is placed as near as possible to the shoulder of the opposite side, the elbow is then carried forward into forward flexion, and the point of the elbow is carried across the front of the trunk while the fingers of the limb under treatment pass further and further upwards over the opposite shoulder. (See Fig. 186.) If the patient is upright, his hand should pass round the back so as to slide over the spine of the scapula until the fingers reach the middle line of the body and perhaps a little beyond it. Leverage is considerable, so the movement should be guarded.

FIG 186 To show how the shoulder joint may be led into full adduction The principle of the movement is similar whether the patient is upright or recumbent The patient's hand should rest on the top of the opposite shoulder The elbow has been extended and the hand supported in order to show the general effect as nearly as possible

External Rotation

External rotation of the humerus is performed by using the same grip as that illustrated when describing the pushing of the head of the humerus upwards on the glenoid (See Figs 169 and 170, p 131) The mobilising force is exerted by turning the trunk If the patient's elbow is not fixed to the trunk the danger is that the mobilising force will be exerted low down on the fore-arm, and the lower it is exerted, the greater the leverage By using the rotation of the operator's trunk as the mobilising force, the amount of force employed can be regulated to a nicety, and also it is far more easy to ensure that the force is impressed upon the fore-arm as near the elbow as possible

Combined Movement

Finally the patient's hands are clasped behind the neck and the elbows are carried as far as possible in a backward direction (*Cf* Fig 196, p 145) This is probably the best form of home exercise

Treatment when Adhesions are Present

When the patient is recumbent, having performed all the movements that are not under voluntary control, if adhesions are present, the movement of adduction across the front of the chest, as already described, should be performed Then, in order to secure abduction, the stabilising hand is passed well up into the axilla, where it rests against the side of the patient's chest wall, the thumb extending backward so as to grasp the axillary border of the scapula This hand then presses the axilla upwards as far as the movement of the scapula will allow The mobilising hand is now placed in contact with the inner side of the upper part of the shaft of the humerus, and the fore-arm of this side rests upon the inner side of the patient's humerus (See Fig 189) The mobilising force is then exerted by the abduction of the operator's shoulder (See Fig 190) It should be possible so to arrange the fingers of the manipulating hand that they rest over the front of the head of the humerus and exert a downward and backward pressure upon it, whilst the operator's fore-arm is performing the desired movement of abduction The control of the mobilising force is perfect It is sometimes taught that the scapula should be moved on the humerus by pressing the lower angle inwards towards the trunk This renders it far more difficult to secure and guard the gliding movement of the head of the humerus on the surface of the glenoid and therefore should not be encouraged

To perform forward flexion of the shoulder when adhesions are present, the grip already familiar when breaking down adhesions by abducting the arm is adopted, and the arm is led into forward flexion in an almost identical manner to that in which abduction was performed (See Figs 191 and 192) As an alternative method the mobilising hand may grasp the back of the patient's arm well up towards the shoulder The base of the stabilising hand is placed over the upper end of the humerus just below the acromion and throughout the movement presses firmly downwards at right angles to the

the humerus are conscious of the fact that the upper end of the bone has slipped either downward, or downward and backward respectively, on the glenoid during the performance of the movement. Should this gliding movement not be present there is only one possible course open to us, and that is to stop and repeat the movements that are not under voluntary control.

FIG 189 To show the grip for performing abduction of the shoulder when adhesions are present The hand which grasps the humerus guides the upper end of the bone under the acromion, while constantly pressing it directly backwards This again is impossible while the patient is seated Note the care taken to avoid forcing external rotation (*Cf* Figs 190 and 191)

Backward Flexion

To perform backward flexion the elbows may be either flexed or extended; if the latter, the fore-arms should be fully supinated. When standing in order to secure a reasonably efficient stabilising force it is usually wise to move the joint on the sound side to the limit of movement and hold it there, before beginning the corresponding movement on the injured side. (See Figs. 165 and 166, pp. 129 and 130.) When recumbent the patient must obviously be placed in the side-lying position, the sound side next the couch. The fixation of the trunk is now complete, so all we have to do is to move the uppermost limb in the manner just described.

Internal Rotation

In order to perform internal rotation the same procedure is followed, and then the humerus having travelled as far backwards as is possible, the sound arm is allowed to drop to the side, while the stiff one is carried round behind the back as far as it will go with comfort. Then, with the back of the fore-arm resting against the patient's back, the arm is carried a little further into extension backwards, so as to raise the fore-arm from the patient's back. Then the elbow is flexed a little further until once more it reaches the patient's back. (See Fig. 188.)

FIG 190 To show how the mobilising force is applied by abduction of the manipulator's shoulder when the grip shown in Fig 189 has been taken Any such guarded movement is impossible with the patient seated

mark the position of the internal epicondyle This must be carried directly forwards from the patient and be guided so that, when the movement is complete, it still points directly forward with regard to the patient and points directly upward with regard to the ceiling (See Fig 194) No rotation of the humerus is possible when full forward flexion is secured, and unless the normal position of rotation is maintained throughout the last stages of the movement, severe injury will be done to normal living structures To force forward flexion without keeping the internal epicondyle in the exact physiological position must lead to disaster So, too, the position of the internal epicondyle must be watched when passing from the position of abduction to full forward flexion In abduction, until the full range is reached as shown in Fig 194, a wider degree of rotation of the humerus is possible, in full forward flexion, as in full abduction, there is none

Fig 195 To show the grip for performing external rotation of the shoulder the patient being recumbent (The peculiar appearance of this photograph is due to the fact that the camera had to be placed above the patient The left hand not the fore arm had to be used in order to secure an uninterrupted view)

External rotation may be performed by placing the patient's fore-arm with the elbow bent to a right angle as near the patient's side as possible The mobilising hand then grasps the patient's fore-arm from the inner side at about the junction of the middle and lower thirds The stabilising hand rests over the inner side of the patient's flexed elbow, with the fingers so placed as to rest between the elbow and the couch Although this is described as the stabilising hand, the object of placing it in this position is that it may slide slowly towards the patient's body while the

Fig 196 To show the final manipulation of the shoulder while the patient is recumbent The mobilising hand is pressing the patient's arm directly backwards towards the couch The corresponding movement in the upright position is secured by standing behind the patient who then places both hands behind the neck The operator then grasps both elbows in the olecranon region and pulls them directly backwards At the same time he leans slightly forward so that the patient's trunk is stabilised against his own chest

FIG 191. To show the grip for breaking down adhesions that limit forward flexion of the shoulder joint (*Cf.* Fig 192)

FIG 192. To show the grip for performing the last stages of forward flexion of the shoulder when adhesions are present, and the patient is recumbent

FIG 193. Once the head of the humerus has vanished under the acromion, the grip on the scapula is released and now the hand, which hitherto had checked the movement of the scapula, guards the head of the humerus so as to ensure that it does not slip downwards and thus risk producing a subglenoid dislocation.

shaft of the bone. The mobilising hand now leads the patient's humerus directly forwards. The difficulty is not to rotate the bone outwards at the same time, but all tendency to do this must be avoided. And so we pass on, provided the head of the humerus has glided satisfactorily under the acromion, till the patient's arm is in the vertical. Now the grip changes and the time is approaching when we can see the vital importance of not externally rotating the humerus during the earlier stages of the movement. A grip similar to that taken for breaking down adhesions that prevent abduetion is again taken, and the arm is carried up beside the patient's head. (See Fig. 193.) The all-important point at this stage is to

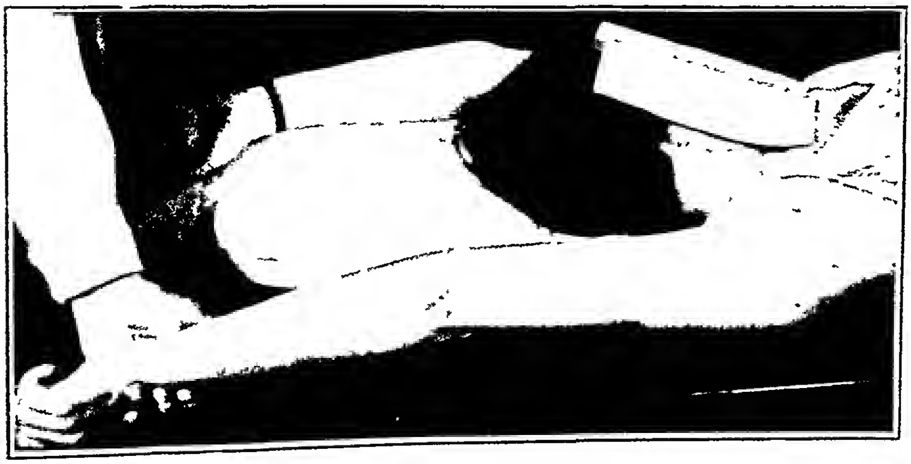

FIG 194 To show the natural position of the internal epicondyle when the position of full forward flexion is reached.

mark the position of the internal epicondyle This must be carried directly forwards from the patient and be guided so that, when the movement is complete, it still points directly forward with regard to the patient and points directly upward with regard to the ceiling (See Fig 194) No rotation of the humerus is possible when full forward flexion is secured, and unless the normal position of rotation is maintained throughout the last stages of the movement, severe injury will be done to normal living structures To force forward flexion without keeping the internal epicondyle in the exact physiological position must lead to disaster So too, the position of the internal epicondyle must be watched when passing from the position of abduction to full forward flexion In abduction, until the full range is reached as shown in Fig 194, a wider degree of rotation of the humerus is possible, in full forward flexion as in full abduction, there is none

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External rotation may be performed by placing the patient's fore-arm with the elbow bent to a right angle as near the patient's side as possible The mobilising hand then grasps the patient's fore-arm from the inner side at about the junction of the middle and lower thirds The stabilising hand rests over the inner side of the patient's flexed elbow, with the fingers so placed as to rest between the elbow and the couch Although this is described as the stabilising hand, the object of placing it in this position is that it may slide slowly towards the patient's body while the

external rotation is being performed. The mobilising force is exerted by the manipulator's fore-arm rotating that of the patient directly outwards. (See Fig. 195.) Leverage, even when this movement is thus performed, is considerable, and great caution is needed.

In order to perform the next two movements the patient must be rolled on to the opposite side. The arm is then carried back as far as possible into backward flexion with the elbow flexed and the fore-arm in the mid-position of rotation. When the limit of movement has been reached the mobilising hand grasps the patient's fore-arm near the wrist, swings it round into full supination and then pulls it backward so as fully to extend the elbow. (*Cf.* Fig. 166, p. 130.) The stabilising hand rests over the back of the patient's humerus near the elbow. The object of this movement is to stretch the long head of the biceps in the tendon sheath. Finally, the patient's fore-arm is again flexed and placed in mid-pronation; in this position it is carried up over the back of the patient's body until the desired degree of internal rotation has been secured.

The last movement is often omitted, and yet, as the late Sir Robert Jones used to point out, it is very often the most important of all. This is to roll the patient once more on to his back, place the hand behind the nape of the neck and then to carry the point of the elbow directly backwards towards the couch as far as the normal range of movement will allow. (See Fig. 196.) It is a remarkable fact that not infrequently adhesions are felt to give way during this movement, even when all the other movements have been cleared by previous manipulation.

CHAPTER XI

THE CLAVICULAR JOINTS

Anatomical Considerations

The scapula being fastened on to the trunk of the body by the clavicle, as far as skeletal structures are concerned, the movements of the scapula entail corresponding movements of the acromio-clavicular and sterno-clavicular joints

The Acromio-clavicular Joint

Structurally this joint presents little which will serve as a guide to the technique of manipulation The only points to be observed are that the facet on the clavicle faces somewhat downwards, and so the outer end of the clavicle will always tend to ride over the acromion if force is impressed upon the point of the shoulder , and also that the joint-line is almost exactly in the antero-posterior plane owing to the fact that the scapula itself is set obliquely on the chest wall

The Sterno-clavicular Joint

This joint is more complicated than the acromio-clavicular joint owing to the presence of the meniscus This is attached firmly to the upper surface of the clavicle The lower surface of the meniscus has no such attachment to the clavicle and is therefore more free to move on the cartilage of the first rib The deltoid ligament, however, which binds the under-surface of the clavicle to the first rib, prevents undue mobility (See Fig 197) At the lower end the meniscus is attached firmly to the junction of the cartilage of the first rib and the sternum, while on the inner side the top of the meniscus is attached to the sternum by the inter-clavicular ligament The joint between the meniscus and the sternum is set somewhat obliquely, the slant being from above downwards and outwards When the clavicle is elevated or depressed the movement takes place at the joint between the meniscus and the clavicle , when it moves forwards or backwards, the movement is between the meniscus and the sternum

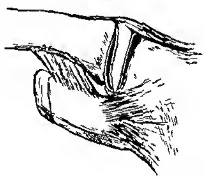

FIG 197 Sketch to show the attachments of the meniscus in the sterno clavicular joint (After Quain)

Movements Not Under Voluntary Control

The Acromio-clavicular Joint

(*a*) *In the Vertical Position.*

The direct manipulation of the acromio-clavicular joint can be performed in the upright position by clasping the fingers of the two hands together and placing the arch thus formed over the top of the shoulder. The heel of one hand rests over the outer part of the convexity forward of the clavicle, while the heel of the other hand rests as near as possible to the under-surface of the spine of the scapula. Both wrists are then fully dorsi-flexed until the two fore-arms are horizontal and in the same straight line. (See Fig. 198.) The hand over the clavicle is then pressed directly towards its fellow, the mobilising force being exerted by the shoulder muscles. Fingers, wrists and elbows play no part in the movement. There is no leverage. The hand on the posterior surface serves as the stabilising hand.

FIG 198 To show the grip for pressing the clavicle backwards in the acromio-clavicular joint, the patient being upright

(*b*) *Recumbent Position.*

In the recumbent position the technique is entirely different and both hands are used in turn as mobilising hands. One hand passes round the front of the patient's chest, and the shaft of the clavicle is grasped between finger and thumb just at the outer limit of the forward convexity. The fingers of the other hand rest over the front of the shoulder joint while the thumb is pressed against the posterior border of the clavicle, as near the acromio-clavicular joint as the circumstances will allow. Care should be taken to see that the position of the scapula itself approximates to the mid-position of elevation. (See Fig. 199.) The outer thumb now presses the outer end of the clavicle forward by the simple process of adducting it towards

FIG 199 To show the grip for manipulating the acromio-clavicular joint, while the patient is recumbent The index finger of the inner hand and the thumb of the outer alternately impress a mobilising force in the antero-posterior direction The patient is recumbent

the fingers As soon as the limit of movement has been reached this thumb is allowed to relax, and then the fingers and thumb of the opposite hand carry the shaft of the bone directly backward by pressure directed vertically over the front of the clavicle

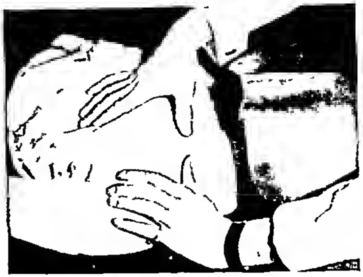

Fig 200 To show an alternative grip for manipulating the sterno clavicular joint The patient is recumbent

The Sterno-clavicular Joint

(*a*) *In the Vertical Position*

It is almost impossible to perform any useful manipulation with the patient in the vertical

(*b*) *Recumbent*

The main movement which can be performed at this joint which is not under voluntary control is the pressing of the inner end of the clavicle directly to and fro It is the backward pressure which is the more important

With the patient recumbent, the shoulder should first be elevated to the full extent towards the patient's ear, and then the outer end of the clavicle is dropped downward for a very short space Both hands serve again as mobilising hands and the grip is very similar to that described for the acromio-clavicular joint The clavicle is grasped by the outer hand as near as possible towards the inner end of the bone between index finger and thumb, the other fingers of this hand rest over the front of the chest (See Fig 200) The thumb of the outer hand is placed above, but well behind, the inner end of the clavicle while the index finger of the inner hand is placed directly over the front of the joint Lateral movement of the wrist of the outer hand now tends to lever the inner end of the clavicle forward, and, when this movement is complete, the hand relaxes entirely while the fingers of the inner hand held rigidly in

Fig 201 To show an alternative manipulation of the sterno clavicular joint

slight flexion at the inter-phalangeal joints, are flexed forcibly at the meta-carpo-phalangeal joints so as to restore, and even accentuate, the original position.

As an alternative, a grip may be used to impress the mobilising force in the manner shown in Fig. 201. Now the thumb of the inner hand rests directly in front of the joint and a side bending movement of the hand tends to drive this thumb vertically backwards over the front of the joint. This hand then relaxes and a corresponding movement of the outer hand tends to restore the original position. The gap shown between the two thumbs is somewhat exaggerated.

(c) *Scapular Movements.*

A third movement in this region which is not under voluntary control

FIG 202 To show grip for securing the elevation of the body of the scapula, away from the chest wall (*Cf* Fig 203)

FIG 203 This shows the final stage in the elevation of the scapula from the chest wall (*Cf* Fig 202) The scapula having been raised in this manner, it may be moved freely in all directions

is the elevation of the scapula itself from the chest wall. In order to perform this the patient should be placed in the side-lying position with the upper arm thrown forward so as to pull the scapula well forward towards the front of the chest. The shoulder region is then elevated as far as possible and the movement of the scapula is controlled by one hand placed over the shoulder. At first this serves as a mobilising hand. and the other hand (stabilising *pro tem.*) is placed with the dorsum of the fingers resting on the back of the patient's chest. The tips of the fingers point directly at right angles to the lower end of the vertebral border of the scapula. Then. while the first hand guides the point of the shoulder backwards and downwards. the fingers of the stabilising hand are insinuated beneath the vertebral border of the bone. (See Figs. 202 and 203.) It is wise that the tips of the fingers should be covered with a layer of lint or similar soft material till the manipulation is familiar; this is to prevent injury from the finger-nails: with adequate

practice it is unnecessary The finger-tips press skin and subcutaneous tissues right underneath the vertebral border of the scapula It is a somewhat difficult matter in many cases to coax the edge of the bone over the fingers, a little perseverance, however, will usually lead to success, especially if the uppermost hand of the patient rests on the inner side of the opposite humerus as it rests upon the couch As soon as the fingers have reached the sub-scapular surface of the bone the whole bone is lifted away from the chest wall as far as it will go, and then both hands carry the scapula freely about in every direction—upwards, forwards, downwards, inwards The scapula must not be allowed to rotate during these movements, or the grip of the fingers under the vertebral border will be lost

Fig 204 To show the grip for performing the full range of movement of the scapula the patient being seated (*Cf* Figs 205 and 206)

Fig 205 To show the degree of elevation of the scapula that can be reached in response to assisted movements when using the grip shown at the starting point in Fig 204 (*Cf* Fig 206)

Movements Under Voluntary Control

The movements of the scapula and of the clavicular joints which are under control can be freed either in the sitting or in the side-lying position In the former the patient sits well back upon the side of a couch in such a position that it is possible to lean comfortably backwards against the chest of the operator The latter then carries one hand round over the sound shoulder of the patient, in front of the chest until the fingers rest beneath the axilla, the anterior border of the axilla resting roughly at the level of the proximal inter-phalangeal joints (See Figs 204 to 206) The other hand is placed over the back of the scapula with the heel of the hand resting directly below the spine of the scapula The fore-arm is now raised until the wrist is fully dorsi-flexed and then both hands simultaneously serve as the mobilising hands The scapula is first raised directly upwards towards the

ear and then is allowed to drop downwards, while both hands carry the body of the scapula forward to the physiological limit. When it can drop no further the return journey is performed, but now the scapula is pulled back towards the middle line as far as possible and the shoulder is raised to the starting position. A very surprising range of movement takes place and very considerable pressure can be exerted by the pressure of the hand over the scapula so as to press the body of the bone down upon the angles of the ribs. Use is frequently made of a corresponding manœuvre when trying to restore lost mobility in the costo-vertebral joints from the third to the sixth or seventh.

FIG 206 To show the degree of forward movement that can be reached by pressing the scapula outwards and forwards It is plain from this figure and Fig 205 that by pressing heavily on the scapula it must be possible, as it were, to grind it against the bed of the chest wall on which it rests It is thus possible not only to free sub-scapular structures, but also to impress movement on the angles of the underlying ribs

In the side-lying position the movement is practically identical, the only difference being that one hand guides the movement of the point of the shoulder while the other rests upon the back of the scapula, usually in a slightly lower position than is used when in the vertical. The main point of pressure exerted by the hand which presses the scapula against the chest wall can be varied, but is usually of more service if the force is applied vertically to the chest wall towards the vertebral border of the bone. This movement is also of service when deposits have formed in the fibrous tissue which lies between the scapula and the chest wall.

There is one not very common, but very troublesome condition, that can only be described as a "squeaking scapula." It is associated with flattening of the normal thoracic curve from the second to the sixth vertebræ. This throws the contour of the angles of the ribs into a plane that so alters the contour of the chest wall that the anterior, concave and hollowed-out surface of the scapula can no longer find a smooth surface on which to glide. Disability may be very severe. The only hope of relief is to restore the mobility of the vertebræ and of the joints between them and the ribs. The manipulation here described is therefore an essential part of relieving—if not of curing—a very real and troublesome condition, which only too often is regarded as a sort of drawing-room trick—a matter for laughter, rather than sympathy, and one that calls for our best efforts at correction.

PART III

THE JOINTS OF THE LOWER EXTREMITY

CHAPTER XII

THE DIGITAL JOINTS

Anatomical Considerations

THE digital joints of the hand have already been fully considered, and, in considering the corresponding joints of the foot, there are few differences to be noted that are of real importance. An examination of the articular facets at the distal ends of the metatarsals shows as the main difference between these and the corresponding facets in the hand, that the articular surface extends far further upward on the dorsum of the metatarsals, thus allowing a much greater normal degree of dorsi-flexion at the metatarso-phalangeal joints than is possible at the metacarpo-phalangeal joints. Unfortunately these joints in the foot have often become chronically deformed as the result of improper foot-gear. In these cases there is always a temptation to manipulate, but the result of manipulation is rarely satisfactory owing to the fact that the apparent deformity is usually due to the insufficiency of the extensor tendons. To ascertain whether the joint or the tendon is most at fault, all that is usually necessary is to push up the head of the metatarsal concerned by pressure upon the corresponding point on the sole of the foot. If the proximal phalanx now drops readily into plantar flexion we know that the joint is not to blame and that joint manipulation will therefore be useless. The remedy is to be found in pressing the head of the metatarsal upwards, using felt supports to transfer part of the body weight-bearing surface to the necks—never to the heads—of the metatarsals, while allowing room in the boot or shoe for the toe to extend.

The ordinary foot supports do not usually give the necessary pressure either in the right place or in the right direction. Commonly the slope on the outer side is not sufficiently oblique to fit accurately behind the heads of the four outer metatarsals, while no adequate provision is made for allowing the head of the first metatarsal to drop into the natural position. It is, in fact, almost impossible that any support taken from stock should fit accurately, the variations in shape of the foot being almost innumerable and extending through a very wide range. A support made of piano-felt or of cork can, however, be shaped to suit almost any case with almost perfect accuracy, and the desired end can thus be attained. The cure of these deformities is

always a rather long and tedious matter, as success often depends on the increase of elasticity in the extensor tendons of the toes, and increase of elasticity is always a slow process. As elasticity increases it is necessary to alter the shape and the position of the support. Although the process is tedious, it is some compensation that perfect foot comfort for the patient can be secured during the whole of the time that improvement is proceeding. (See Figs. 207 to 209.)

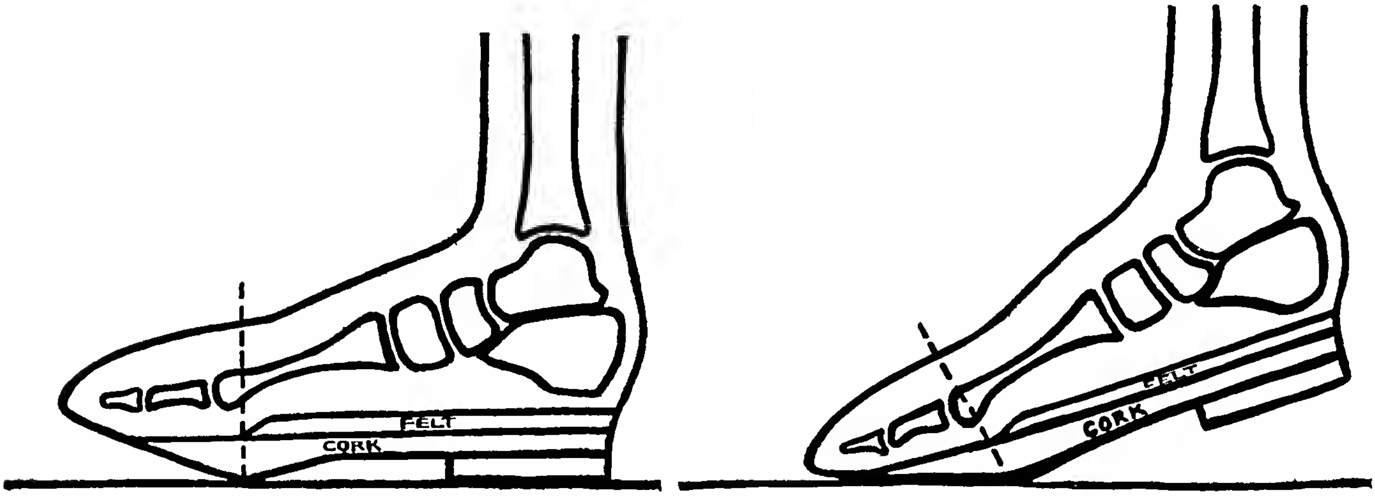

FIG 207 To show how the great toe can be allowed to rest without dorsi-flexion when the heel is raised If greater effect still is required a metatarsal bar may be added (See Fig 208)

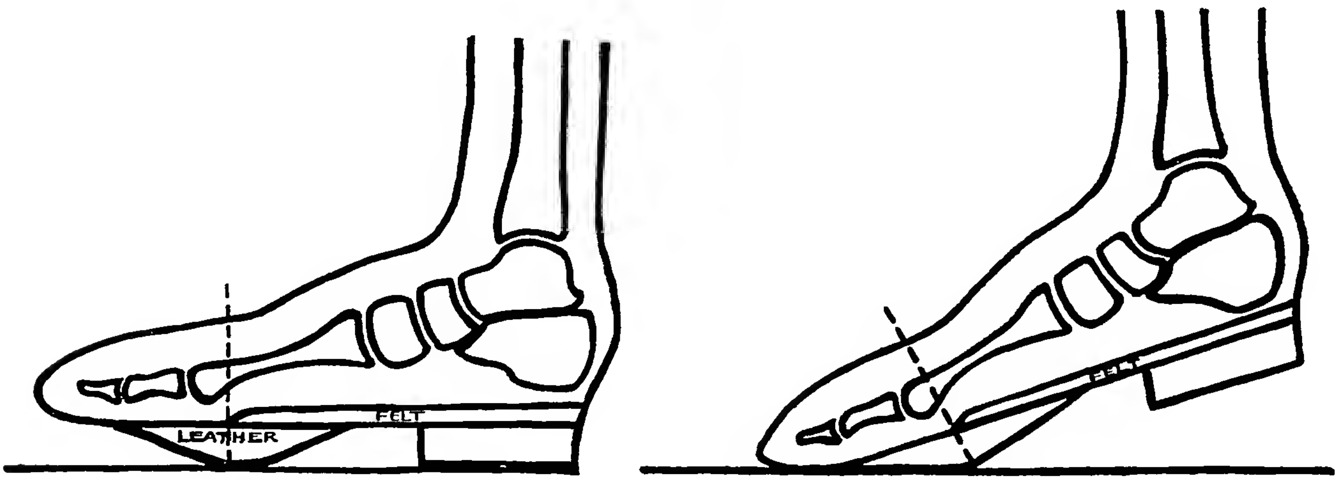

FIG 208 To show how the "rocking" effect shown in Fig 207 can be increased by the addition of a metatarsal bar This must be placed obliquely across the sole—preferably between the welt and the sole—so that the maximum elevation is just behind the heads of the first and fifth metatarsals The obliquity and the position are both common sources of error

A special word is necessary concerning the first metatarso-phalangeal joint. There are countless people who suffer from definite foot disability owing to limitation of dorsi-flexion in this joint. In these cases every step that pushes the phalanx to the limit of movement must of necessity inflict a certain amount of irritation on the joint. As a rule, of course, the degree of irritation is infinitesimal, but, however trifling the injury may be, it is

repeated some nine hundred times for every mile walked, and nine thousand times for every ten miles, and such multiplication must in the end result in permanent damage, in the form of chronic traumatic osteo-arthritis. The logical conclusion is that if the full range of painless movement can be restored in time, irritation, which is the cause of the arthritis, will cease, and the patient may very possibly be saved from the curse of a hallux rigidus. Permanent success is, however, only possible if all other causes of irritation are also removed. One of the commonest of these is the habitual wearing of a shoe which is either too short or is not provided with adequate mechanism for keeping the heel of the foot well back in the heel of the shoe. If the tip of the big toe has no room between itself and the toe of the shoe, either a hallux rigidus or a hallux valgus is the almost inevitable result. Too short a stocking or sock is almost as pernicious as too short a shoe.

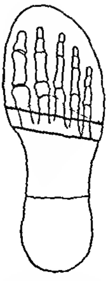

FIG. 209. To show the relative positions of the metatarsal bar and the contour of a felt pad adjusted so as to fit behind the heads of all five bones. It will be noticed that this contour differs very materially from the usual ready made variety.

Manipulation

As to the nature of the manipulation of these joints there is nothing to be added to what has been indicated concerning the corresponding joints of the hand. The important question is when it is wise to manipulate and when it is wise to refrain. On this point no hard and fast rule can be laid down; each case must, as always, be considered on its own merits. It may, however, safely be said that if a boss of bone can be felt standing up from the dorsal aspect of the head of the first metatarsal directly behind the joint-line, then it will be impossible to rotate the base of the phalanx upwards over the protuberance, and any attempt to do so will either be unavailing or will cause such injury to the ligaments that recovery will be rendered impossible. On the other hand, there are many cases of marked hallux rigidus in which the boss of bone cannot readily be detected, and in this event it is wise to give the patient the benefit of the doubt and try how far matters can be improved by manipulation. The result will quite often be found to exceed expectation. In cases of hallux valgus, unfortunately, corresponding treatment leads through to success less frequently, from the cosmetic point of view, though pain may be relieved.

If we decide that manipulation must fail, there are two alternatives—to operate or to provide the patient with foot-gear which raises the heel and also removes the necessity for dorsi-flexion of the hallux. This can be accomplished satisfactorily by building the foot-gear on the rocker principle. A glance at Figs. 207 and 208 will demonstrate this principle. Fig. 207 shows how a shaped cork insole can provide the required effect, while Fig. 208 shows how the effect can be increased by a crossbar of leather inserted between the sole and the welt. If no great height of heel is required to compensate for too short a tendo Achillis or flexor longus hallucis, the bar alone may be adequate. It should not be more than a third to half-an-inch in depth.

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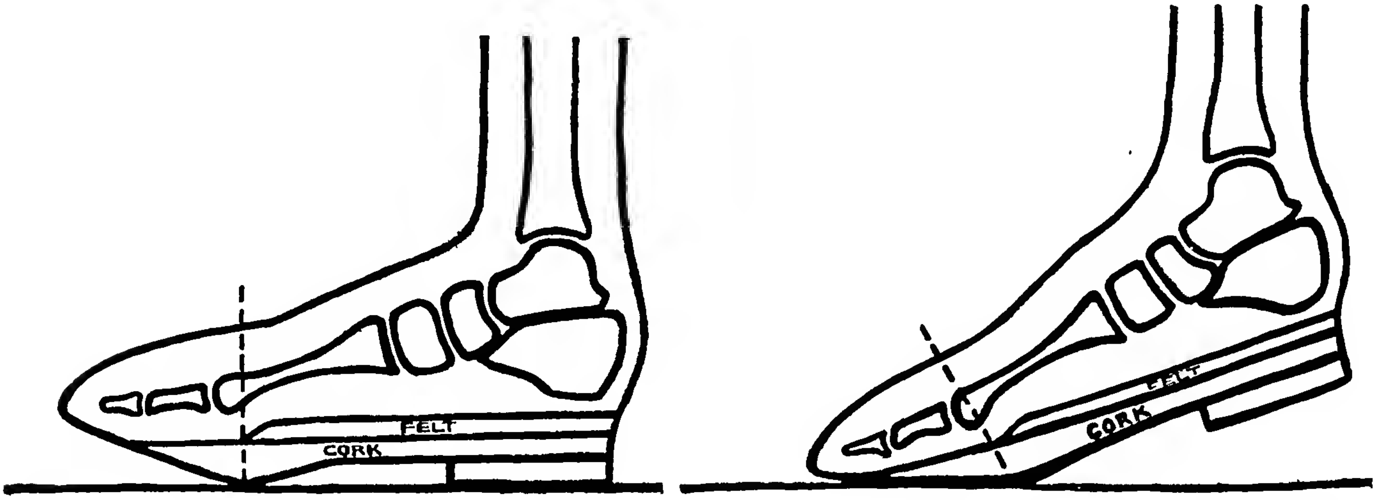

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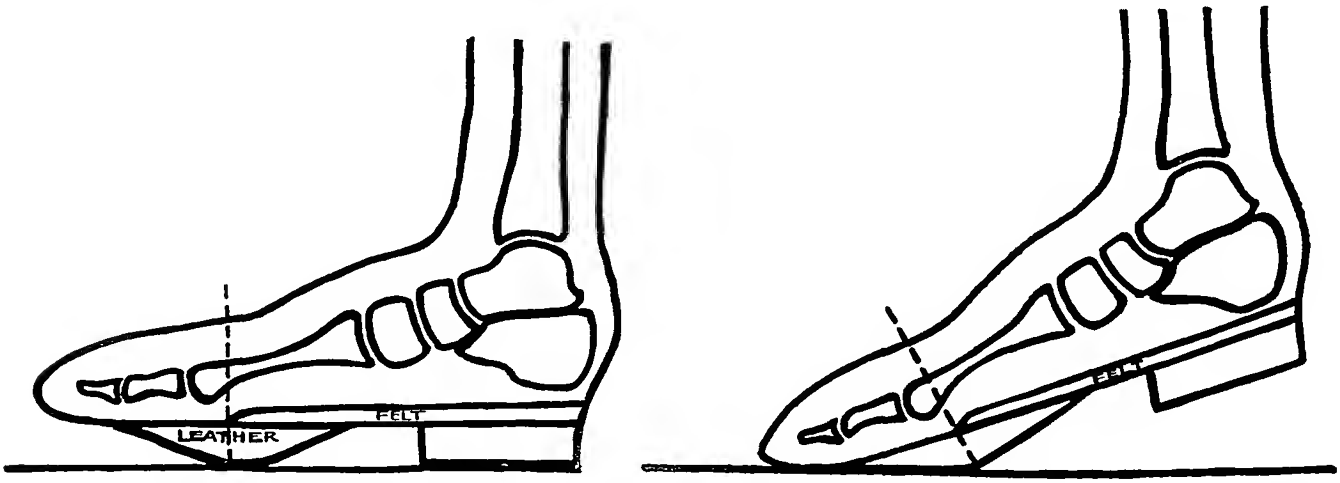

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the base of the third metatarsal It has no articulation with the first (See Fig 211) The joint surfaces between the second and third metatarsals and between the second metatarsal and the external cuneiform are both divided into two parts by a strong interosseous ligament (See Fig 212)

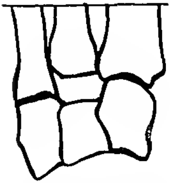

Fig 211 To show how the base of the second metatarsal is wedged firmly between the other bones Pulling the base forwards gives the appearance of an articulation with the first but this in fact does not exist

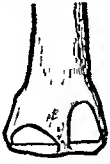

Fig 212 View of the outer side of the base of the second metatarsal to show how the joint surface between the base of the second and that of the third is split into two by the interosseous ligament The same applies to the articulation with the external cuneiform

Fig 213 View of the inner side of the base of the second metatarsal to show the joint surface that articulates with the internal cuneiform

Fig 214 To show how the base of the third metatarsal is wedged between the other bones There is still the appearance of a joint between the first and second metatarsals but this single line is due to overlap owing to the position into which the bones were set so as to obtain a correct view of the space required

Fig 215 To show the joints on the inner side of the base of the third metatarsal

Fig 216 To show the joint surface on the outer side of the base of the third metatarsal

The area of either pair of facets is very considerably larger than the area of the facets provided on the opposite side for articulation with the internal cuneiform (See Fig 213) The articulations with the external cuneiform are smaller than those with the third metatarsal

CHAPTER XIII

THE METATARSAL JOINTS

Anatomical Considerations

"Dropping of the anterior metatarsal arch" is a diagnosis quite often made, and yet it is anatomically indefensible. The one essential principle of the mechanism of the foot is that every one of the five metatarsal heads should rest upon the ground at the same time. If they were to form an arch in the true sense of the word, the whole weight of the body would be on the heads of the first and fifth metatarsals, while the heads of the other three would be off the ground altogether. In practice if any one of the three middle metatarsal heads is, owing to their being cramped together by the foot-gear, not free to come down and rest upon the sole of the shoe, we are faced with one cause of Morton's metatarsalgia. This particular cause of pain connected with the condition is the nipping of the soft structures between the adjacent heads, which have to slide upon one another while being pressed together by the shoe leather. The pain of similar compression of the bones of the hand is known to every schoolboy, and yet, when dealing with the bones of the foot, the effect of compression is seldom considered. The objections stated above to the term "anterior metatarsal arch" do not apply with the same force to the term "posterior metatarsal arch" as describing the arch formed by the bases of the metatarsals; but we must not forget that this is a direct continuation of the transverse tarsal arch, which is certainly not of less, and is probably of greater, importance.

Fig 210 To show the shape of the articular facet at the base of the head of the first metatarsal of the left foot

Passing now to the consideration of the joints at the bases of the metatarsals, the joint at the base of the first claims particular attention. It is plain from the shape of this joint, which is utterly unlike the corresponding joints, that its movements also must be entirely different from those at the other joints. The facet is approximately kidney-shaped with the hilum facing outwards (see Fig. 210); and this indicates plainly that the movement of the first metatarsal on the internal cuneiform cannot be simply one of dorsi-flexion and plantar flexion, but that the base of the bone must necessarily pass through part of an arc of a circle when travelling from the one position to the other.

When we come to consider the base of the second metatarsal we find that it is very cunningly wedged in between the three cuneiform bones and

turn reduces the liability to injury as the result of abnormal stress and strain The joint between the second and the third metatarsal is divided into two by the interosseous ligament and thus freedom of mobility is relatively impaired

There is a condition known to orthopædic surgeons, in America rather than in this country as the atavistic toe The expression is used to indicate the quite common bony development when the shaft of the first metatarsal is abnormally short

Fig 219 To show the relative lengths of the first and second metatarsals in a normal foot (*Cf* Fig 220)

Fig 220 Photograph of a patient to show the conditions present in a case of atavistic toe Note that the first metatarsal is relatively very short when compared with the second and that the amount of cancellous bone is materially reduced throughout the shaft of the second metatarsal while the amount of hard bone is greatly increased This is to ensure as far as possible that the second metatarsal shall be able to take over part of the weight bearing function for which in a normal foot it is not intended

compared with that of the second Since structurally the first metatarsal is plainly intended to be the main weight-bearing bone of the inner side of the foot, and since, when its shaft is abnormally short, the head of the second is unduly prominent anteriorly, it follows that the latter has to do more weight-bearing than was intended by Nature, and, when this is so, the structure of the second metatarsal undergoes definite change (See Figs 219 and 220) As a consequence of the unnatural stress of the weight of the body which is thus imposed on the second metatarsal, an impressed force acting upon the head of the bone in an upwards direction, with the great leverage which is involved, is plainly likely to lay such a strain on the mechanism of the joints at the base as may lead to a

The base of the third metatarsal, articulating with only three bones instead of four, is not wedged in so compactly as the second on the inner side. (See Fig. 214.) As we have seen, the articular facet between the second and third metatarsals is divided into two parts (see Fig. 215); but the combined area of these two parts does not exceed that of the single facet for the articulation of the third with the fourth. (See Fig. 216.)

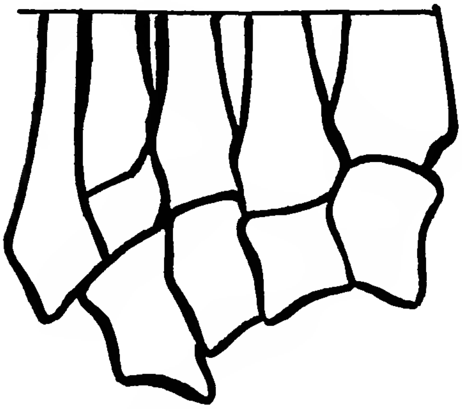

Fig 217. To show how the base of the fourth metatarsal is wedged between other bones

The plane of the joint between the second metatarsal and the internal cuneiform is approximately transverse; that of the bases of the third and fourth is oblique from before backwards and outwards, while the fifth is slightly more oblique in the same general direction.

Whereas the base of the third metatarsal articulates with three bones, that of the fourth articulates with four, namely, at the sides with the third and fifth metatarsals, at the base with the cuboid, and also with the external cuneiform by means of a little facet at the angle between those for the third metatarsal and the cuboid. (See Fig. 217.) The joint surface between the third and fourth metatarsals is separated by a sharp ridge from that which articulates with the external cuneiform, and there is only one relatively large facet for articulation with the fifth metatarsal.

The fifth metatarsal has two articular facets, again separated by a sharp ridge, one for the outer side of the fourth metatarsal and the other for the cuboid. (See Fig. 218.)

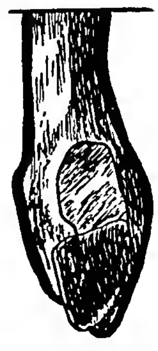

Fig 218 To show the joint surfaces on the inner side of the fifth metatarsal

The two metatarsals, therefore, with the most complicated joints at their bases are the seeond and the fourth; and, owing no doubt to this faet, when trouble arises in this region, these two points are the areas most frequently affeeted. Indeed, considering the extreme eomplexity of the joints eoneerned with the movements at the base of the seeond metatarsal, and the leverage exerted by an impressed force on the head of the bone, it is easily understood how the very delicate meehanism of some of the smaller joints at the base may be materially upset by sueh impressed foree. The fourth metatarsal is on the whole less vulnerable than the second, but this same argument applies. The single joint surface between the fourth and fifth allows a very large degree of mobility of the fifth upon the fourth, and this freedom of mobility is a disadvantage for the fourth, as it reduees the protection afforded to the complicated joints at its base. The danger is, however, diminished by the fact that the articular faeet between the fourth and the third metatarsals is single and undivided, thus allowing greater freedom of movement, which in

Of course it is a fact that the full range of movement procurable by manipulation must, at least on occasions be secured during the ordinary physiological movements of the foot Yet the muscles, though voluntary cannot perform the movement independently of other movements Moreover, muscular movement in the foot attains to full activity only when the foot is supporting the superimposed weight of the body This undoubtedly has a bearing on the apparent inefficiency in the performance of fine movements of individual joints, as the muscles act to best advantage only when opposed by the forces inherent in the function of weight-bearing The muscles are not constructed to perform fine movements but rather to render strength, stability and support to the joints as part of a general co-ordination But for the weight-bearing function of all structures in the foot the muscles might have developed along lines which would have enabled them to perform movements at individual joints, which as things are, are quite beyond their powers True enough some quite exceptional persons have succeeded in training the muscles of the foot to act independently so as to enable them to be used for writing and painting but we are now dealing with the consideration of the ordinary civilised foot—only too often barbarously ill-treated by civilised foot-gear Many of the foot muscles seem to have as their main function in contracting, one object only, namely, that of stabilising some bone or joint so as to enable other muscles to do their work efficiently The sum of all these points is the conclusion already stated, namely, that the difficulty in differentiating between movements which are, and which are not under voluntary control is insuperable

Movements of the First Metatarsal

The nature of the movements which can be performed at the base of the first metatarsal is indicated quite clearly by the formation of the kidney-shaped facet Moreover, when viewed from above, a convexity on the fore-part of the internal cuneiform fits into a concavity on the base of the first metatarsal The latter, however, is not so wide transversally as that on the cuneiform, and we must remember that the base of the first metatarsal does not usually articulate with the second Therefore there are no ligaments binding the two bases together These facts allow a wider range of lateral mobility to the first metatarsal than is possible to the others

The stabilising hand grasps the inner side of the foot with the fingers under the sole, and the thumb rests transversely across the cuneiforms The internal cuneiform is grasped firmly between the proximal phalanges of thumb and first finger, while the more distal parts control the rest of the tarsus (See Fig 223) The thumb of the mobilising hand is then placed directly across the dorsum of the foot from without inwards till it rests over the neck of the first metatarsal The forefinger passes underneath the sole and grasps the plantar surface of the neck of the bone just opposite to the position of the thumb The distal part of the first metatarsal is then raised towards the dorsal aspect as far as it will go but it will be found that by swinging the metatarsal head well over towards the outer side of the foot a

definite binding between the adjacent articular surfaces of some joint in this region.

There is little that need be said about the joints where the bases of the metatarsals articulate with the tarsus. The most striking feature is the wedge-like form of the bases of the three middle metatarsals, the base of each wedge being towards the dorsum of the foot, while the apex passes down towards the plantar aspect. (See Fig. 221.) This forms the foundation of the transverse areh at the base of the metatarsals, which is completed on the inner side by the front part of the internal cuneiform. (See Fig. 222.) The back parts of the internal cuneiform and of the middle and external cuneiforms with the cuboid together form the transverse tarsal areh. This is really the key to much of the natural and physiological movement of the fore part of the foot. The cuboid is the main support on the outer side and the internal cuneiform on the other.

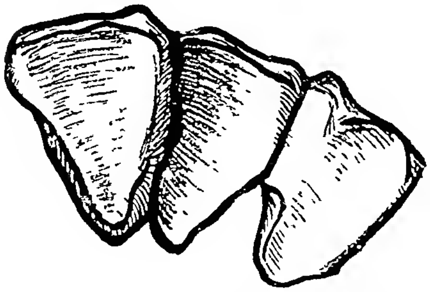

FIG 221 To show the wedge-shape of the bases of the three middle metatarsals The bones are slightly separated

Movements Not Under Voluntary Control

There is not much to be written about these movements. The principal movement is traction, and the application of this has already been adequately described. It can, of course, only be transmitted to the bases of the metatarsals through the metatarso-phalangeal joints. Although it is difficult to perform at these joints any movement which is not technically under voluntary control, yet it is impossible to perform voluntarily, as an independent individual movement at any given joint, the full range which is theoretieally under voluntary control. The museles whieh eontrol the movements of the joints of the foot eonsist of striped or voluntary fibres ; but nevertheless they are, for the most part, only eapable of acting voluntarily as part of a general eo-ordinated movement. It is hard to eoneeive for instance any person being able to swing the shaft of the fifth metatarsal round the fourth almost in a semieirele without some corresponding movement in other joints of the foot, yet this should be within the range of voluntary movement, aeeording to the anatomical structure. Therefore, when we perform a movement whieh is theoretically voluntary at the base of a metatarsal, the faet that we move it as a single entity practically makes the movement one that is not under voluntary control. This also applies to most, if not all, manipulations of the joints of the foot.

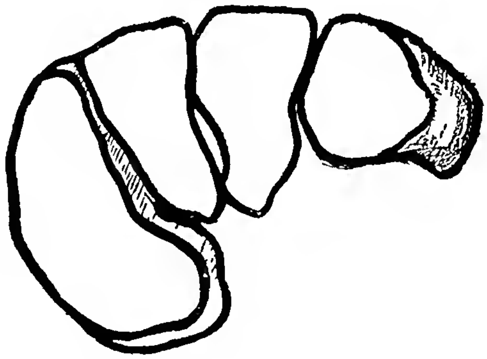

FIG 222. The view of the tarsal bones from in front showing the formation of the tarsal arch to which the arch formed by the bases of the metatarsals is attached The fourth and fifth metatarsals articulate with the cuboid, but the division of the two facets was not clear to the artist owing to the obliquity at which the joint surfaces were set The foreshortening makes the articular surface on the cuboid appear to be smaller than in fact it is

the first The neck of the bone is grasped between finger and thumb of the mobilising hand We have already seen (see last paragraph, page 159) that the impressed force that is calculated most readily to cause derangement at the base of the bone is an upward pressure upon the head of the bone, it follows, therefore, that the manipulation which will be most calculated to restore lost mobility (after traction has been applied) is the pressing down of the head of the bone towards the sole It has also been seen that the base of this bone rests in a bony hollow well surrounded and firmly gripped by the three cuneiform bones and the third metatarsal (See Fig 211, p 157) Therefore we should not expect to find any great degree of mobility in any direction other than directly towards the dorsal and plantar aspects of the

Fig 225 To show the start of the mobilising movement of the joints at the base of the fourth metatarsal The mobilising thumb having depressed the head of the bone as far as possible towards the sole now presses it firmly inwards as if to carry it underneath the head of the third metatarsal (*Cf* Fig 226)

Fig 226 To show the end of the movement begun in Fig 225 Here the index finger of the mobilising hand having elevated the head of the fourth metatarsal as far as possible now presses it as if to carry the head of the bone over the dorsal aspect of the third The mobilising force is mainly shoulder movement

foot Of rotation there is practically none, but, on the inner side, the joint which articulates with the internal cuneiform does not extend distally along the shaft to anything like the extent to which the articulations between the second and third metatarsals extend on the outer side (See Figs 212 and 213 p 157) It follows, therefore, that such mobility as is present is mainly towards the inner side of the foot Therefore, while raising or depressing the bone, the impressed force should not be applied solely in a direction vertical to the shaft of the bone, but should also tend to swing it round in a manner similar to that described when manipulating the first metatarsal—only, of course, a very much smaller range of movement will be secured

Movements of the Third and Fourth Metatarsals

Much the same may be said of the manipulation of the third metatarsal, only now it is to the obliquity of the proximal facet at the base of the bone

considerable increase of movement can be secured. Then, by pressing the head of the bone well towards the inner side of the foot, the circular movement which has already been performed is reversed, and the shaft of the bone is carried inwards and downwards as far as it will go. Again, having reached this point, it will be found that, if the head of the bone is again carried in an outward direction, a considerable further range of movement will be secured. Thus we see that the movement is not one of dorsi- and plantar flexion, and that the head of the bone travels round the circumference of a wide arc, the concavity of the arc being directed towards the outer side of the foot. The impressed force which controls the upward and downward movement is mainly one of fore-arm rotation combined with palmar flexion and dorsi-

FIG 223 To show the grip for mobilising the first tarso-metatarsal joint This is the starting position (*Cf* Fig 224) The head of the metatarsal is here shown in position of elevation and is being pulled outwards

FIG. 224. To show the termination of the movement begun in Fig 223 Note the degree of pronation of the mobilising hand The full extent of this is somewhat masked by the greater degree of dorsiflexion The head of the metatarsal is here depressed plantar-wards to the full extent and is being pulled outwards.

flexion of the hand. (See Figs. 223 and 224.) The fingers must remain as rigidly fixed as possible, but the incidence of the impressed force varies so much during the course of a very wide range of movement that elbow, wrist and shoulder must of necessity take part in the movement to some extent.

Perhaps the most generally useful manipulation of the metatarsal region is that shown in Fig. 231, p. 165. In fact, the relief afforded by it may often be classed as one of the "miracle cures" of the bone-setter; the patient hobbles in with pain and difficulty and goes away—often after a single movement—rejoicing in the absence of both. It is wise, however, to investigate all the joints from the ankle distally and to restore to them any mobility that may be lacking.

Movements of the Second Metatarsal

For manipulation of the joints at the base of the second metatarsal the stabilising hand takes a grip corresponding to that taken when manipulating

manipulating the third metatarsal the shaft of the bone should be made to describe an arc convex outwards around the second In the same way the shaft of the fourth should be made to follow a corresponding arc round the shaft of the third (See Figs 225 and 226, p 163)

FIG 231 To show how the stabilising grip should be changed from that shown in Fig 229 when dealing with the joints at the bases of the other metatarsals

While manipulating the joints at the bases of the second, third or fourth metatarsals it will be found that it is extremely difficult to gain an adequate grip between finger and thumb if the tip of the first finger is employed If, however, this finger is curled up so that the two distal joints are in full flexion, it will be found that the palmar surface of the thumb fits accurately against the side of the proximal inter-phalangeal joint of the finger The most suitable grip, therefore, is to grasp the shaft of the metatarsal as near as possible towards the head between the palmar surface of the thumb and the lateral surface of the curled-up index finger This is shown in Figs 225 and 226, p 163, and should be contrasted with the grip shown in Figs 223 and 224, p 162

Movements of the Fifth Metatarsal

Now when we come to the manipulation of the base of the fifth metatarsal we find that the shaft of the bone may be swung around the shaft of the fourth metatarsal through a range of movement very little, if any, less than that performed during the manipulation of the first metatarsal The difference, however, is that, whereas the convexity of the arc of movement of the first metatarsal is directed directly inwards, that of the fifth is directed directly

FIG 232 To show the beginning of the mobilisation of the metatarsals *en masse* (See Fig 233)

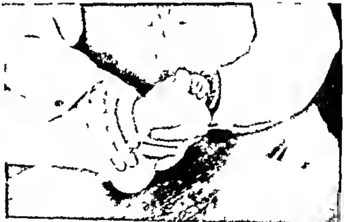

FIG 233 To show the end of the movement begun in Fig 232 Note once more that the stabilising hand has hardly moved in the two photographs The mobilising force is again mainly shoulder movement

that attention must be paid. (See Fig. 214, p. 157). The obliquity corresponds so closely to that between the base of the fourth metatarsal and the cuboid that the range of lateral movement is greater than when we were

FIG 227 To show the start of the mobilising movement of the joints at the base of the fifth metatarsal The head of the bone is here shown carried into full dorsi-flexion and then pushed over towards the inner side (*Cf* Fig 228)

FIG 228 To show the end of the movement begun in Fig 227 Note that the stabilising hand has scarcely moved in spite of the wide range of movement shown Again the head of the bone is pressed firmly towards the inner side The mobilising force is mainly shoulder movement

FIG 229. To show the start of the alternative method of manipulating the joints between the bases of the first and second metatarsals (*Cf* Fig 230) The thumb depresses the head of the first metatarsal while the index finger elevates that of the second

FIG 230 To show the end of the movement begun in Fig 229 Note again that the stabilising hand has barely moved in spite of the wide range of movement of the mobilising hand The index finger of the mobilising hand now elevates the head of the first metatarsal while the thumb depresses that of the second

dealing with the second. Lateral mobility, however, is mainly towards the outer side instead of towards the inner, and this fact must be regarded when manipulating either the third or fourth metatarsals. Therefore, when

coincide with the photographs, but in practice it is usual to stand facing the patient and then, of course, all details should be reversed It was impossible to secure photographs of the movement when facing the patient, and so a position is adopted which while efficient, is not commonly used in practice

When dealing with the remaining metatarsals it is wise to change the grip of the stabilising hand to the outer side of the foot (See Fig 231) The difference in technique will be seen by reference to Figs 229 and 231

Movement *en masse*

Just as it was found desirable, when dealing with the corresponding joints in the hand, to ensure that the mobility of the metacarpus *en masse* was complete, so, too, it is wise to do the same thing when dealing with the joints at the bases of the metatarsals The stabilising hand takes exactly the same grip as before, the thumb of the mobilising hand is placed transversely across the dorsum of the foot near the bases of the toes, while the fingers pass transversely across the sole The index finger rests distal to the heads of the metatarsals, the middle finger over the heads and the fourth finger behind them (See Figs 232 and 233) The fore-part of the foot, consisting of the metatarsals only, is carried as far as possible into dorsi-flexion Then it is carried laterally inwards, plantar-wards, and finally outwards, the process being continued while the metatarsus as a whole is carried slowly as far as it will go from dorsi-flexion into plantar flexion The metatarsus as if one piece is then carried over towards the inner aspect of the foot and then towards the outer aspect as far as it will go in both directions

Fig 236 Alternative method of forming an arch of the fore part of the foot

To complete the manipulation of the metatarsus it is necessary to arch and flatten, as far as possible, the fore-part of the foot just behind the bases of the toes For this purpose each of the two first fingers is curled up so as to form a hook and the thumbs are placed transversely across the dorsum , the hooks of the index fingers grasp the plantar surfaces of the head of the first metatarsal on one side and of the fifth on the other By a movement that really amounts to little more than fore-arm rotation, the bones are moved first of all as if to form an arch of the metatarsal heads, the concavity of which is directed towards the sole (See Fig 234) Then the hands are swung round so as to approximate the two thumbs on the dorsum which press plantar-wards simultaneously, while the two hooks formed by the index fingers separate and pull the heads of the first and fifth metatarsals apart and towards the dorsal aspect (See Fig 235)

An alternative method of securing the full arching of the sole is by

FIG 234 To show the movements of increasing and decreasing the metatarsal arch This photo shows the movement for increasing the metatarsal arch, while Fig 235 shows that for flattening it

outwards. The full manipulation of the joints at the base of this bone therefore consists in carrying the head of the bone as far as it will go towards the dorsum of the foot, and, while continuing pressure in this direction, in carrying the head of the bone towards the inner side of the foot. During the return journey the head of the bone is caused to travel downwards and outwards, then directly downwards, then downwards and inwards and finally inwards once more. (See Figs. 227 and 228, p. 164.)

Alternative Method

When dealing with the manipulation of the joints at the bases of the metacarpal bones an alternative method of impressing the desired force was described. The same movement is applicable in every way to the treatment of the bases of the metatarsals. The objective now is to raise the head of one metatarsal towards the dorsum while depressing the head of its next-door neighbour; and, having done this, to reverse the manipulation. In order to secure this movement, the stabilising hand grasps the dorsum of the foot as before and (when mobilising the joint at the base of the first metatarsal) the mobilising hand is passed from the outer side so that the thumb rests transversely across the dorsum of the foot and the first finger in a corresponding position directly across the sole. (See Figs. 229 and 230, p. 164.) Then, while the thumb on the dorsum presses the head of the first metatarsal down towards the sole, the index finger is employed in pulling the second metatarsal upwards and towards the outer side. (See Fig. 230.) Then, when the movement is reversed, the tip of the index finger presses the head of the first metatarsal directly up towards the dorsum of the foot while the thumb is employed in moving the shaft of the second metatarsal downwards towards the sole and finally inwards. (See Fig. 229.) This description is given to

FIG 235 To show the end of the movement begun in Fig 234 Note that the distal joints of the curled-up index fingers rest underneath the heads of the first and fifth metatarsals, the middle phalanges being placed parallel with the shafts of the metatarsals As a rule the operator would stand facing the patient, but this placed him between the camera and the patient's foot, and it was found impossible to secure any reasonable view of the grip taken This photo and Fig 234 merely show the hands reversed—the grip is identical

coincide with the photographs, but in practice it is usual to stand facing the patient and then of course all details should be reversed It was impossible to secure photographs of the movement when facing the patient, and so a position is adopted which while efficient, is not commonly used in practice

When dealing with the remaining metatarsals it is wise to change the grip of the stabilising hand to the outer side of the foot (See Fig 231) The difference in technique will be seen by reference to Figs 229 and 231

Movement en *masse*

Just as it was found desirable, when dealing with the corresponding joints in the hand, to ensure that the mobility of the metacarpus *en masse* was complete so, too, it is wise to do the same thing when dealing with the joints at the bases of the metatarsals The stabilising hand takes exactly the same grip as before, the thumb of the mobilising hand is placed transversely across the dorsum of the foot near the bases of the toes while the fingers pass transversely across the sole The index finger rests distal to the heads of the metatarsals the middle finger over the heads and the fourth finger behind them (See Figs 232 and 233) The fore-part of the foot, consisting of the metatarsals only, is carried as far as possible into dorsi-flexion Then it is carried laterally inwards, plantar-wards, and finally outwards, the process being continued while the metatarsus as a whole is carried slowly as far as it will go from dorsi-flexion into plantar flexion The metatarsus as if one piece is then carried over towards the inner aspect of the foot and then towards the outer aspect as far as it will go in both directions

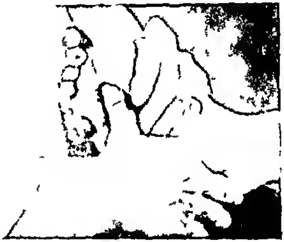

FIG 236 Alternative method of forming an arch of the fore part of the foot

To complete the manipulation of the metatarsus it is necessary to arch and flatten, as far as possible, the fore-part of the foot just behind the bases of the toes For this purpose each of the two first fingers is curled up so as to form a hook and the thumbs are placed transversely across the dorsum, the hooks of the index fingers grasp the plantar surfaces of the head of the first metatarsal on one side and of the fifth on the other By a movement that really amounts to little more than fore-arm rotation, the bones are moved first of all as if to form an arch of the metatarsal heads, the concavity of which is directed towards the sole (See Fig 234) Then the hands are swung round so as to approximate the two thumbs on the dorsum which press plantar-wards simultaneously, while the two hooks formed by the index fingers separate and pull the heads of the first and fifth metatarsals apart and towards the dorsal aspect (See Fig 235)

An alternative method of securing the full arching of the sole is by

placing the thumb of the stabilising hand on the sole of the foot behind and between the heads of the second and third metatarsals. The mobilising hand is placed transversely across the dorsum, the thumb grasping the outer side of the shaft of the fifth metatarsal near the head, while the palmar surface of the index finger secures a grip on the inner side of the first metatarsal. By adducting the thumb and first finger of the mobilising hand the metatarsals can be arched over the stabilising thumb in the sole. (See Fig. 236.)

CHAPTER XIV

THE TARSAL JOINTS

Anatomical Considerations

As has already been noted, the plantar surface of the three cuneiform bones and the cuboid form a very sharp transverse arch across the sole of the foot (See Fig 222, p 160) This arch is completed behind by the scaphoid The keystone of the arch is the middle cuneiform, and in shape this coincides exactly in contour with the keystone of the arch of a bridge It is probably very fortunate for us all that the stability of this arch is secured

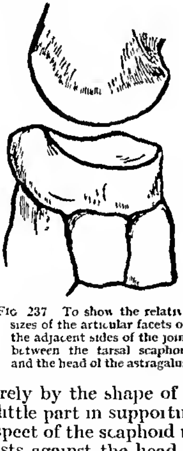

Fig 237 To show the relative sizes of the articular facets on the adjacent sides of the joint between the tarsal scaphoid and the head of the astragalus

Fig 238 To show the relative sizes of the articular facets on the adjacent sides of the joint between the anterior part of the body of the os calcis and posterior part of the cuboid

almost entirely by the shape of the bones, and that the muscles play comparatively little part in supporting the tarsal arch The joint surface on the posterior aspect of the scaphoid is shaped so as nearly to form a perfect arch where it rests against the head of the astragalus, but the anterior facet at the distal end of the astragalus is considerably greater in all dimensions than the corresponding surface on the scaphoid (See Fig 237) On the anterior aspect of the scaphoid the articular facets which connect it with the three cuneiforms do not form the same perfect line, and that for the external cuneiform causes the line to sink backwards towards the heel somewhat suddenly (See Fig 237) So, too, when we come to consider the articulation

on the posterior aspect of the cuboid, we find that this surface is considerably smaller in depth than that on the front of the os calcis with which it articulates. (See Fig. 238.) This arrangement of necessity allows of a very considerable mobility, and it is mainly due to the movements that take place in the calcaneo-cuboid joint and to a less extent in the astragalo-scaphoid

FIG 239 To show the grip for securing pronation of the fore-part of the foot The thumb of the right hand (hidden from view) is preventing movement of the os calcis

FIG 240 To show the range of movement when the fore-part of the foot is carried into supination with the same grip as that shown in Fig 239 The fingers of the right hand are now preventing movement of the os calcis The heel is pressed firmly down on to the couch (*Cf* Figs 241 and 242)

joint that the movements of pronation and supination of the fore-part of the foot can be performed. The range of these movements is extremely wide, as will be seen by reference to Figs. 239 to 242.

In addition, however, to these two movements there is a considerable lateral mobility of the fore-part of the foot upon the back part and also towards the dorsum and towards the plantar aspect of the foot.

FIG 241 To show the X ray appearance of the bones when the fore part of the foot is held in pronation (Cf Fig 239)

FIG 242 To show the X ray appearance of the bones when the fore part of the foot is held in supination The shadows thrown by the astragalus and the os calcis in Fig 241 are so closely identical with those seen in Fig 242 that we must realise that almost the whole of the change in relative position takes place in the mid tarsal joints Note that the head of the astragalus has hardly moved at all

We are now left with the consideration of the sub-astragaloid joints—the joints at which inversion and eversion of the foot take place It is a common practice to speak of the movements of inversion and eversion of the ankle joint but, in fact, this movement is almost non-existent A glance at Figs 243 to 245 will show the significance of this observation When however, we come to the consideration of manipulation of the joints, it is essential to keep in mind that the movement of the fore-part of the foot may take place through an extremely wide range without any trace of movement

FIG 243 To show the grip on the os calcis when —
(i) applying traction to the ankle or sub-astragaloid joints,
(ii) performing dorsi-flexion and plantar flexion of the ankle,
(iii) performing inversion (as shown) or eversion of the foot at the sub-astragaloid joints

taking place at all between the os calcis and the astragalus and this may lead to confusion between the movements of the fore and back parts of the foot. It is essential that they should be isolated. Hence it comes about that claim is made to much movement by manipulation of the joints of the foot which is entirely fictitious. Here, above all, it is necessary to remember that, if we wish to move a joint, it is essential to fix the bone on one side of the joint while moving the bone on the other side. There is one peculiarity that requires special notice when

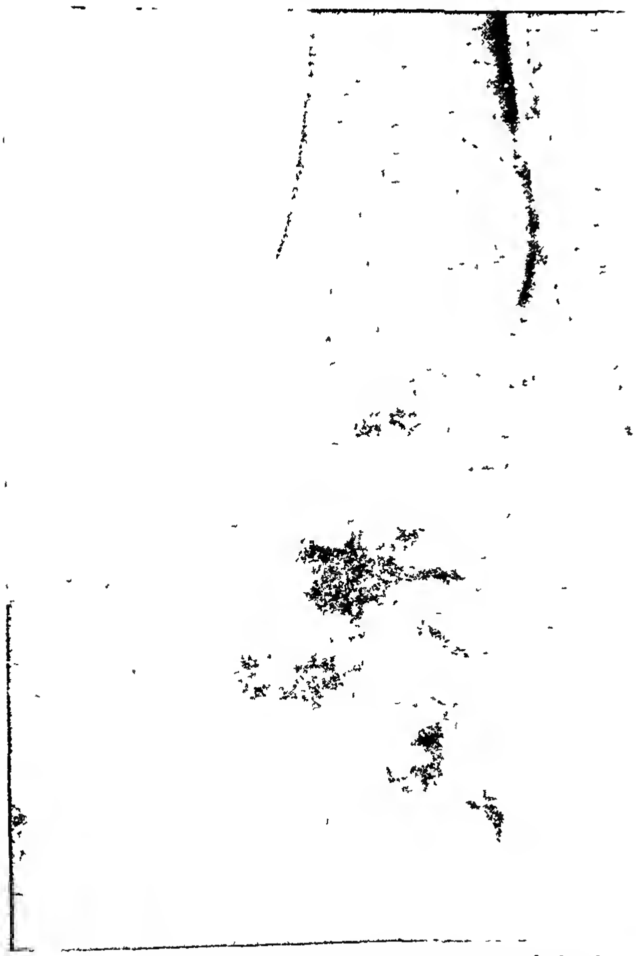

FIG 244 To show the X-ray appearance of the bones when the foot is inverted as shown in Fig 243

FIG 245 To show the X-ray appearance of the bones when the foot is fully everted

Note that the relationship of the astragalus to the tibia is unaltered in Figs 244 and 245, thus showing that inversion and eversion of the foot do not take place at the joint between these two bones, i e, at the ankle joint

considering the posterior and anterior articular surfaces between the astragalus and the os calcis, this is that, whereas the posterior surface presents a continuous curve the front surface is divided into two facets by a ridge of varying sharpness on the astragalus which, of course must fit accurately into a corresponding concavity on the upper surface of the os calcis (See Fig 246) It therefore becomes apparent that whereas little harm will come of a torsion strain of the posterior articulation, a corresponding strain of the anterior may very easily lead to lack of proper alignment between the transverse ridge on the astragalus and the corresponding hollow on the os calcis Moreover it will be noticed that the posterior articular facet on the under-surface of the astragalus is of far greater dimensions than the corresponding facet on the os calcis (see Fig 246) (far greater, in fact, than is shown on the sketch owing to fore-shortening), showing that a very wide range of sliding movement must be possible at this joint On the outer side of the astragalus, just below the articular facet for the external malleolus, the contour of the bone assumes that of a sharp prominence (see Fig 253, p 179) which dips down sharply into a corresponding hollow on the os calcis, which must limit movement at this point very markedly There is no such limiting mechanism on the inner side Thus the range of inversion is far greater than of eversion (*vide infra*) The possibility of the two bones binding on one another in the hollow on the os calcis is a very real one that doubtless accounts for the tedious convalescence after so many sprains of the joint unless the mobility of the two joint surfaces is restored by manipulation—preferably by traction and often by this alone The anterior articular surfaces between the two bones are relatively narrow, but the total area occupied by articular cartilage is considerably less on the os calcis than on the corresponding facets on the under-surface of the astragalus

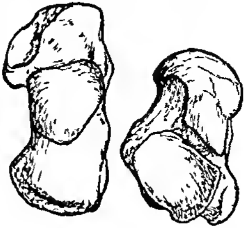

Fig 246 To contrast the areas and contours of the joint surfaces on the upper surface of the right os calcis and the plantar surface of the astragalus The astragalus has been lifted from the top of the os calcis and has then been rotated until the under surface faces directly upwards

Movements Not Under Voluntary Control

Again it is to all intents and purposes impossible to distinguish between those movements which are normally under voluntary control and those which are not No one, for instance, by voluntary exercise of their muscles can pronate and supinate the fore-part of the foot upon the back part through a degree of movement than even approaches approximately to that which can be performed by an external agency However, this matter has already received detailed consideration when dealing with the movements of the joints of the metatarsals and so requires no repetition (see p 160)

Pronation and Supination of the Fore-part of the Foot

To perform these movements the stabilising hand passes over the dorsum of the foot with the thumb passing obliquely baekwards and downwards below the external malleolus towards the point of the heel, while the first finger grasps the inner side in a corresponding position below the internal malleolus. Often it is well to flex the knee to an angle of not less than 45 degrees, though, as shown in the photos, this is not essential. The point of the heel is pressed firmly against the couch by the stabilising hand. (See Figs. 239 and 240, p. 170.) It is quite impossible to perform the necessary movements adequately unless the os calcis is firmly wedged between the stabilising hand and an entirely unyielding surface. The web between the finger and thumb of the stabilising hand rests across the dorsum just behind the articulation between the head of the astragalus and the seaphoid. The thumb of the mobilising hand is then passed across the dorsum of the foot while the fingers pass in a corresponding transverse position aeross the sole. Keeping fingers, wrist and elbow as rigidly fixed as possible, the mobilising force is then exerted from the shoulder so as to swing the front of the foot into supination while the tips of the fingers of the stabilising hand prevent the faintest trace of a corresponding movement in the os ealeis. Then, when the movement is reversed and the sole of the foot is swung round into pronation, all outward movement of the os calcis is prevented by the thumb on the outer side of the same bone.

Lateral Movement of the Fore-part of the Foot

The grips taken are identical with those for performing pronation and supination, but to lateralise the fore-part of the foot, while maintaining the grip of the mobilising hand, the part of the foot in front of it is earried by the mobilising hand first direetly towards the inner side and then directly towards the outer side.

Movements Under Voluntary Control

Dorsi- and Plantar Flexion of the Fore-part of the Foot

As already noted, it is really impossible to differentiate between the movements of the joints of the foot that are and are not under voluntary control. The movements of dorsi-flexion and plantar flexion of the fore-part of the foot are, however. more under voluntary eontrol than those we have so far eonsidered. In order to perform these movements a grip may be taken by the stabilising hand identieal with that previously deseribed (see Figs. 247 and 248), and the grip of the mobilising hand is also similar. The thumb of the mobilising hand passes transversely over the dorsum of the foot approximately at the level of the metatarso-phalangeal joints. If the fingers are elosed somewhat obliquely aeross the sole. it will be found that the ulnar side of the hand will rest. roughly speaking. just proximal to the heads of the metatarsals. Fingers. wrist and elbow are now fixed as firmly as possible. and the impressed force is transmitted from the shoulder. first. so as to carry the fore-part of the foot plantar-wards as if to approximate

the metatarsal heads as far as possible towards the heel, a movement which should aim at increasing the longitudinal arch to a maximum The pressure downwards must be distributed as nearly as possible evenly across the whole of the dorsum of the foot and should not aim mainly at depressing the first metatarsal though, of course, if this is stiff it must be loosened first of all (See p 161) The metatarso-phalangeal joints must be fully dorsi-flexed

When this movement has been performed to the fullest extent the whole of the fore-part of the foot is pulled upwards so as, as it were, to flatten out the longitudinal arch to the fullest extent The toes should be plantar-flexed As shown in Figs 247 and 248, much of the mobilising force in performing this movement is derived from fore-arm rotation It should be noted, however that the objective of the movement is to move the whole of the fore-part of the foot together and not to lay any undue stress upon the joint between the base of the first metatarsal and the internal cuneiform This should have been dealt with separately, and calls for no special attention at this point

Fig 247 To show the grip for plantar flexing the fore part of the foot upon the back part

Fig 248 To show the grip for dorsi flexing the fore part of the foot upon the back part Note the relative positions of the big toe as shown in Figs 247 and 248 and compare with Figs 239 and 240 p 170 Note also that the astragalus has been prevented from taking any part in the movement

Movements of the Cuboid

Finally, it is always wise to test the mobility of the cuboid as a single bone The thumb of the stabilising hand is placed over the outer side of the bone while the fingers pass round the outer side of the foot on to the sole so as to secure as firm a grip as possible between the thumb and the adjacent side of the proximal phalanx of the index finger This digit should be curled up into a hook Now, while the thumb and first finger grip and stabilise the cuboid, the fore-part of the foot is pronated and supinated upon it—a movement which is the exact

Fig 249 To show the grip for the manipulation of the cuboid

FIG 250 To show an alternative method of manipulating the joints of the cuboid

equivalent of pressing the outer side of the cuboid downwards and inwards towards the centre of the sole during pronation, while in supination it is raised and rotated outwards. (See Fig. 249.)

A second manipulation of the cuboid that is eminently satisfactory I owe to a chiropodist in Los Angeles. The right palm grasps the right os calcis from behind and raises the leg for a short distance. The grip is taken so that the thumb rests on the plantar surface of the bone. The left hand grasps the dorsum of the foot somewhat anterior to the palmar hand. As a final adjustment to the hands, the two forearms are placed transversely at right angles to the foot. (See Fig. 250.) The hands, wrists and elbows remain rigid while the mobilising force is applied by shoulder rotation adducting the two elbows to the sides of the body. The plantar thumb is thus driven dorsal-wards while the fore-part of the foot is rotated by the hand on the dorsum which also arches the whole of the outer part of the foot—concave downwards.

Movements Not Under Voluntary Control

The Sub-Astragaloid Joints

Traction

The first, and by far the most important, is traction. In performing this movement, however, it must be realised that traction applied promiscuously over the dorsum of the foot will largely be expended upon the joints in the fore-part of the foot, and that the movement will therefore only reach those under consideration to a very limited extent.

The patient must be treated recumbent, and the heel is raised by the stabilising hand so that the two sides of the os calcis are grasped between the palmar surfaces of the fingers and the thenar and hypothenar eminences. (See Fig. 243, p. 172.) The distal joints of the fingers should not be flexed unduly so as to pinch, but they should rest in almost complete extension against the side of the os calcis. Considerable care is required in securing the grip of the hand on the dorsum of the foot. The web between the thumb and first finger is placed horizontally across the dorsum and is inserted accurately just distal to the joint between the tarsal scaphoid and the head

of the astragalus The first finger passes obliquely downwards and backwards to a point below the external malleolus, and the thumb takes a corresponding grip on the other side (See Fig 251) When this grip is secured, but not before, the rest of the hand is allowed to drop down upon the dorsum of the foot, and the fingers close around the plantar aspect Any traction now employed is applied to the os calcis, the hand on the dorsum is merely there to stabilise and control It is essential to distinguish at this point between traction applied to the ankle joint and that applied to the sub-astragaloid joint It is impossible to exert traction on the posterior aspect of the astragalus except indirectly by the pull on the os calcis, in other words, traction on the sub-astragaloid joint must be applied before it can be transmitted to the ankle joint, so far as the posterior part of the bone is concerned It is, however, possible to secure a sufficient grip on the anterior part of the astragalus over the head of the bone to exert considerable traction upon it and so to secure direct traction upon the ankle joint This movement takes no part in the manipulation of the sub-astragaloid joint, and while performing the movement care should be taken not to exert traction upon the upper aspect of the fore-part of the astragalus, the os calcis, and the os calcis only, should receive the application of the mobilising force It will be found, however, that the maximum traction can only be secured if the foot is held in a moderate degree of plantar flexion This rotates the heel backwards and so provides a convex surface on which a far firmer grip can be secured than if the foot is allowed to dorsi-flex, so that the Achilles tendon stands up as a rigid impediment to the securing of an adequate grip on the upper part of the back of the os calcis The mobilising force which exerts the traction on the os calcis so as to separate it from the astragalus is exerted mainly through the back muscles of the operator Once the grip has been secured, fingers, wrist, fore-arm, elbow and shoulder should be fixed as rigidly as possible, while the operator, by leaning backwards, exerts the maximum possible traction upon the os calcis so as to pull it away from the astragalus The line of pull must be as nearly as possible in a direction directly parallel with the long axis of the fibula this is a safer guide than if we use the long axis of the tibia, as the curve at the lower end of the bone is liable to be misleading To receive the maximum benefit from traction the sub-astragaloid joint must rest exactly in the mid-position between inversion and eversion

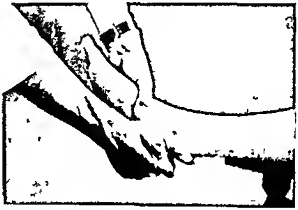

FIG 251 To show the grip illustrated in Fig 243 p 172 completed when mobilising the sub astragaloid joint (*Cf* the difference in grip of the stabilising hand when mobilising the ankle joint as shown in Fig 256 p 180)

A very useful—and often more valuable—method of applying traction indirectly through the os calcis, is described on p 181

Movements Under Voluntary Control

These consist of inversion and eversion, and to perform them efficiently it is necessary that the astragalus should be locked as firmly as possible in the ankle joint. It has been said above that the movements of inversion and eversion of the foot do not take place primarily in the ankle joint, and this is true whatever the position of the astragalus may be. When the foot is plantar flexed it becomes only relatively true, because in this position a slight degree of inversion and eversion of the astragalus within the mortise of the ankle joint becomes possible. Therefore, in order to stabilise the astragalus as completely as possible it is necessary to place it in dorsi-flexion. The astragalus having been thus locked as far as possible in the ankle joint, the os calcis is moved upon its lower surface. The mobilising hand grasps the back of the heel and the two sides of the os calcis as before, while the stabilising hand is placed over the dorsum of the foot just distal to the head of the astragalus. Under no circumstances, however, is this hand to be used as a mobilising hand ; it is merely a guiding hand to steady the direction of the movements imparted by the mobilising hand which is grasping the os calcis. The mobilising force is mainly transmitted from the shoulder and should be directed to imparting a movement from side to side of the os calcis on the astragalus with a slight side-bending movement. The nature of this movement can be judged by reference to Fig. 246, p. 173, and by reference to p. 172. Another useful method of dealing with the sub-astragaloid movements in conjunction with movement of the ankle joint is described on pp. 181 and 182.

CHAPTER XV

THE ANKLE REGION

Anatomical Considerations

The movements of the ankle consist of the movements of the body of the astragalus within the mortise of the joint which is formed by the outer side of the internal malleolus, the under surface of the tibia and the inner side of the external malleolus The surface that articulates with the internal malleolus is set in a plane almost directly antero-posterior in relationship

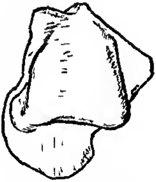

Fig 252 View of the left astragalus taken from above and slightly from behind to show how the articular surface on the head of the bone broadens in front

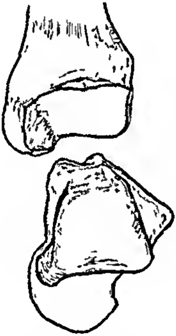

Fig 253 To show the relative sizes of the adjacent articular surfaces in the ankle joint The astragalus has been removed from its place and rotated until the upper surface faces directly backwards

Fig 254 To show the downward drooping of the mortise of the ankle joint seen from in front

with the tibia, that for the external malleolus is set in a plane which is oblique from behind, forwards and outwards (See Fig 252) This means that the articular facet which articulates with the lower end of the tibia, though set generally in an antero-posterior plane, is broader in front than behind It is owing to this fact that there is a small degree of true inversion and eversion at the ankle joint when the foot is plantar flexed, and that the

FIG 255 To show the shape of the facets on the astragalus that articulate with the malleoli—the outer to the left

range of these movements decreases steadily as the foot is dorsi-flexed. Of necessity the articular facet on the upper surface of the body of the astragalus is considerably longer antero-posteriorly than the corresponding surface at the lower end of the tibia. (See Fig. 253.) Then, in addition, running directly antero-posterior, there is a groove on the upper surface of the body of the astragalus which is concave upwards, and this fits into a corresponding convex surface on the lower end of the tibia. (See Fig. 254.) However truly, therefore, we may speak of the "mortise" of the ankle joint, we are bound to admit that the horizontal part between the two pillars at the sides has, as it were, given way somewhat so that the arch sags down slightly in the middle. The appearance is quite readily seen when the lower end of the tibia is examined from in front rather than from behind; and we must remember that, although there is a deep mortise to the ankle joint when viewed from in front, from the side aspect it disappears very materially, existing only as a comparatively shallow depression.

Finally, it will be noted that while the articular facet on the inner side of the external malleolus is roughly oval, that on the outer side rather resembles a parallelogram. (See Fig. 255.) All these observations have a direct bearing on the movements of the joint, and for the most part they tend towards securing stability. There is no joint surface between the tibia and fibula at the lower end, the points of contact being occupied entirely by the interosseous ligament.

Movements Not Under Voluntary Control

Traction

The grip for applying traction has already been described when considering the application of traction to the sub-astragaloid joint. The grip in the present case is identical, with one exception, namely, that now the hand over the dorsum of the foot is employed equally with that which grips the heel when the traction is applied. It is important, therefore, that the grip should be taken as far backwards along the neck of the astragalus as possible. Thus it is essential to plantar flex the foot to the full

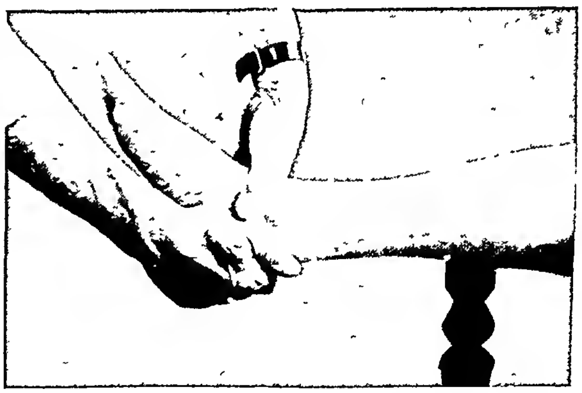

FIG 256 To show the grip illustrated in Fig 243, p 172, completed when mobilising the ankle joint Cf Fig 251, p 177, which shows the corresponding grip for exerting traction on the sub-astragaloid joint Having secured the grip over the neck of the astragalus as shown here, the palm of the left hand drops down on to the dorsum of the foot before traction is applied

extent before securing the grip, having secured it, the foot is then dorsi-flexed to about the mid-position. It is very important that it should not be fully dorsi-flexed, as, if this is done, a large amount of the force expended will be wasted in a futile attempt to stretch the tendo-Achillis. The force applied is derived from the body weight of the manipulator pulling in a direction directly parallel to the long axis of the fibula. (See Fig. 256.)

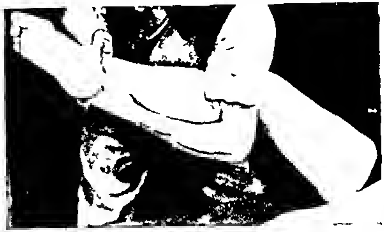

Fig. 257. The method of applying traction to the sub astragaloid and ankle joints, the ultimate mobilising force being flexion of the knee.

Another useful and ingenious method of attaining the same end was described by Marlin. (See Figs. 257 and 258.) Standing with his side towards the patient the operator passes the hand next to the patient across the leg to the inner side and then grasps the back of the heel between thumb and first finger, the thumb remaining on the inner side of the heel, the fingers lying to the outer side. The tendo-Achillis rests in the web between the thumb and the index finger. Once secured it must never relax; if any adjustment is required after flexion of the knee has started the knee must be straightened before the grip is retaken. The elbow and the knee are now bent, and the hip is also flexed and slightly rotated outwards. The back of the manipulating arm is so placed as to come up into contact with the posterior surface of the patient's thigh above the knee joint, and it will be found that the greater the degree of flexion of the knee, the more firmly will the back of the operator's arm be pressed up against the back of the thigh. Presently the fore-arm will be firmly wedged between heel and thigh, and it is at this point that, by increasing flexion of the knee still further, a very strong degree of traction is laid upon the os calcis. The stabilising hand is placed on the dorsum of the foot, which is held in a very considerable degree of plantar flexion, so that the os calcis may form a sharp prominence for the stabilising hand to grasp. The hand on the dorsum serves the dual purpose of stabilising the foot in plantar flexion and of imparting the movement of

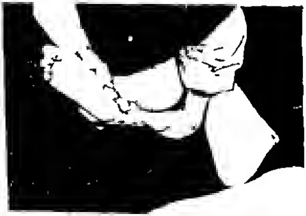

Fig. 258. To show how, by flexing the knee when the grip shown in Fig. 257 has been taken, the back of the left arm is driven up against the back of the patient's thigh and at right angles to it. Further flexion shortens the distance from heel to thigh and so, if the grip on the heel is firm, a very considerable traction is placed upon the ankle joint.

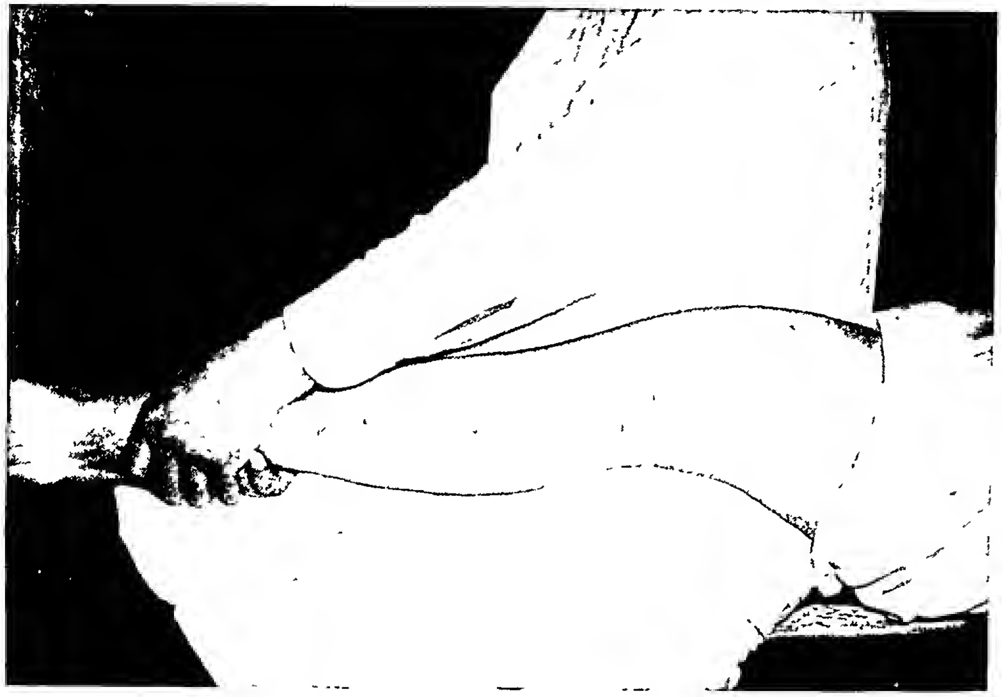

FIG 259 To show an alternative method of applying traction to the sub-astragaloid and ankle regions It is particularly useful if knee flexion is deficient

flexion of the knee. It is this movement which directly applies the extension force necessary to move the astragalus directly away from the lower end of the tibia. When performed in this way the traction is often accompanied by an audible snap, which it is comparatively unusual to hear when the traction is applied by the first method. One precaution is needed, namely to avoid the temptation of allowing the olecranon to rest upon the back of the thigh as it does if the hip is not adequately rotated outwards. The triceps forms a cushion between the back of the humerus and the back of the femur. A similar procedure can be used when applying traction to the fore-arm. (See p. 90.)

An alternative method is shown in Fig. 259. The operator sits on the side of the couch facing the inner side of the joint being treated. His trunk then replaces the back surface of the arm as previously described. For some reason it is more difficult to teach the first method than the alternative, though the reason for this is not very obvious. [I owe this alternative method to my son, Dr. John McM. Mennell.]

FIG 260 To show the grip for performing the antero-posterior movement of the tibia on the astragalus The os calcis is pressed firmly into the couch, and the force exerted on the lower end of the tibia must be at right angles to the shaft of the bone as it is carried to and from the astragalus (Cf Figs 261 and 262)

Antero-Posterior Movements of the Mortise on the Astragalus

After the traction has been employed the knee is flexed until the heel rests comfortably on the couch with the toes elevated and in such a position that the foot is roughly in the

mid-position between dorsi-flexion and plantar flexion The stabilising hand is then placed over the dorsum of the foot, the web between finger and thumb resting over the neck of the astragalus, while the thumb passes downwards to the outer side of the body of the os calcis and the fingers take up a corresponding position on the inner side (See Fig 260) The mobilising hand then grasps the lower end of the leg just above the point where the transverse diameter begins to spread out to form the two malleoli The thumb is to the outer side, the fingers to the inner side The stabilising hand then presses the back of the os calcis firmly against the

Fig 261 To show the X ray appearance of the relative positions of the bones when the tibia is pressed backwards on the astragalus

table or if the surface is soft, upon a board or thick book placed upon the surface The surface should be as unyielding as possible The mobilising hand then carries the tibia and fibula anteriorly and posteriorly on the surface of the astragalus The fore-arm of the mobilising hand must exert pressure directly vertical to the long axis of the leg bones The degree of movement is shown in Figs 261 and 262

Another method of attaining the same end is to place the support

Fig 262 To show the X ray appearance of the relative positions of the bones when the tibia is pulled forward on the astragalus Note the complete stabilisation of the tarsal bones

underneath the lower part of the back of the leg so that the os calcis is just free to pass to the full limit of plantar flexion. The stabilising hand is now that which grasps the leg bones as before, and the hand on the dorsum of the foot becomes the mobilising hand. It is essential that the knee should be well flexed, and then the mobilising hand is passed down the inner side of the foot, the fingers resting underneath the back of the heel while their tips grasp the outer side and the base of the heel the inner side. (See Fig. 263.) The mobilising force is now exerted by pulling the os calcis directly forwards while at the same time causing it to perform the movements of dorsi-flexion and plantar flexion of the foot through a small range. Not very much can be done by way of plantar flexion with the hand in this position, but a very considerable force can be exerted in the direction of dorsi-flexion. Then, to perform plantar flexion the position of the mobilising hand is reversed. The same grip is taken as that described in the first method of applying traction to the ankle joint (see Fig. 256, p. 180), and now the dorsum of the foot is pressed directly downwards and backwards towards the couch while the movement of plantar flexion is being performed.

FIG 263 To show the grip used to pull the astragalus forward on the tibia while performing the movement of dorsi-flexion of the ankle

Combined Movements

Though as a general rule it is most unsatisfactory that two movements should be performed at separate joints at the same time, yet there is one manipulation which is often extremely useful and which involves the combined movements of the ankle and of the sub-astragaloid joints. This consists of flexing the knee of the patient approximately to a right angle, placing the back of the heel upon the table while grasping the lower end of tibia and fibula with the mobilising hand, the stabilising or guiding hand holding the foot with the thumb transversely across the dorsum and the first finger—preferably curled up into the form of a hook—lying transversely across the sole from without inwards. (See Figs. 264 and 265.) The mobilising hand and forearm now press on the leg bones at right angles to their long axis and the mobilising force is exerted by alternately flexing and extending the knee. This movement of the knee, when the back of the os calcis is fixed, so as to press the astragalus (which is super-imposed upon the os calcis) forward on the lower end of the tibia, must at the same time cause dorsi-flexion of the foot when the knee is flexed, and plantar flexion when the knee is extended. Now if, with the heel fixed as before, the thigh is adducted so that the leg below the knee forms a slightly acute angle with the couch, the astragalus must of necessity be everted while the foot passes from dorsi-flexion to plantar flexion and the reverse. If, on the other hand, the thigh is abducted the os calcis will be inverted while

the ankle continues the movements of dorsi-flexion and plantar flexion

A certain amount of discretion is required when applying these various movements, since it frequently happens that, if dorsi-flexion is limited, all that is required in order to restore a full range of movement is to press the astragalus backwards in the ankle joint If, on the other hand, plantar flexion is the movement which is deficient, it sometimes suffices merely to press the astragalus forward in the ankle joint in order to restore full mobility If dorsi-flexion and plantar flexion of the ankle joint are administered while applying traction, a very little manœuvring with the two hands will enable the manipulator to impress a force which will move the astragalus forward on the tibia during plantar flexion or backward during dorsi-flexion

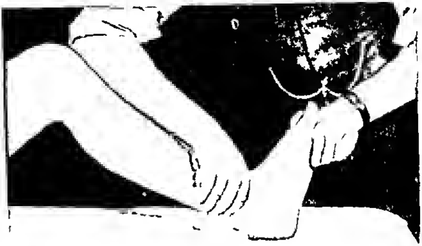

FIG 264 To show how the foot may be moved into dorsi flexion by flexing and extending the knee if the heel is anchored firmly on to the couch (*Cf* Fig 265)

FIG 265 To show how the foot may be moved into plantar flexion by extending the knee if the heel is anchored on to the couch The left hand merely stabilises while the right hand pulls upwards in the long axis of the tibia (in Fig 264) and presses downwards in the same line in Fig 265 This hand at the same time presses firmly downwards towards the couch at right angles to the tibia and the whole weight of the fore arm reinforces the pressure

Movements Under Voluntary Control

These consist of plain dorsi-flexion and plantar flexion of the astragalus on the lower surface of the tibia with a very small range of true adduction and abduction when the ankle is plantar flexed The point which now arises, and it is an extremely important one, is what will happen if we try to force the movement of dorsi-flexion in the ankle when impediment exists It is useless merely to dorsi-flex the fore-part of the foot, thus flattening out the longitudinal arch It is not adequately realised how frequently there exists a relative insufficiency of the tendo-Achillis, of the flexor longus hallucis or of both, and, when this is present, it is utterly

impossible to place the ball of the big toe and the heel simultaneously on the same horizontal plane (for example, as in standing on the floor) without flattening out all the structures in the sole of the foot. Hence it comes about that very frequently when a plaster splint is applied so as to include the foot (and particularly in the case of a Pott's fracture) the fore-part of the foot is pushed up apparently under the delusion that dorsi-flexion of the fore-part of the foot is the equivalent of dorsi-flexion of the ankle. Few things can be more disastrous, and it is therefore very important to keep this fact in mind while performing the movements of dorsi-flexion and plantar flexion of the ankle by manipulation, and particularly when this precedes the application of a plaster splint. The whole of the fore-part of the foot must be left severely alone, and dorsi-flexion must be performed, with the knee well flexed to relax the tendo-Achillis (by moving the os calcis), and through it the astragalus, in the upward direction. Then, to perform the movement of plantar flexion the hand upon the dorsum of the foot should be so placed that the proximal side of the index finger rests upon the lower end of the front aspect of the tibia. The web between finger and thumb must fit accurately over the neck of the astragalus. If on examination the movement is not completely free, it is well to perform once more those movements which are not under voluntary control. While performing the movement of plantar flexion a small degree of lateral movement may be superimposed.

CHAPTER XVI

THE KNEE REGION

Anatomical Considerations

THE movement of the knee joint is always complicated by the presence of the two semilunar cartilages, these rest on the upper surface of the tibia and their presence deepens on both sides the cup into which the lower end of the femur fits (See Fig 266) On examining the lower end of the femur it will at once be noticed that the articular surface both on the inner side and on the outer is very markedly greater in extent than the corresponding surfaces on the tibia upon which it rests The difference in size is more marked on the inner side than on the outer, and it is due to this fact that the wide rotation of the tibia on the femur is possible (See Fig 267) It is, however, only possible in flexion as in full extension—and by this must be understood in most of us hyper-extension—the rotatory movement

FIG 266 To show how the depressions on the upper surface of the tibia are deepened by the semilunar cartilages to receive the lower articular surfaces of the femur The photograph shows the bony contour of the tibia of the opposite side when stripped of the cartilages

ceases to exist as the rotation of the tibia on the femur, or of the femur on the tibia (as the case may be) has reached the anatomical limit and further movement is thus checked

The integrity of the crucial ligaments is the next vitally important point in stabilising the knee joint, they are, however relatively slack except in full extension and in full flexion Throughout the intermediate stages both are sufficiently lax to allow a considerable range of antero-posterior mobility of the tibia on the femur, moreover it is only when the knee is locked in full extension that the lateral ligaments also are at full stretch The reason for this is abundantly obvious when the contours of the convexity of the articular surfaces on the lower end of the femur are examined The movement of the phalanx upon the head of a metacarpal illustrates exactly the movement of the tibia around the lower end of the

impossible to place the ball of the big toe and the heel simultaneously on the same horizontal plane (for example, as in standing on the floor) without flattening out all the structures in the sole of the foot. Hence it comes about that very frequently when a plaster splint is applied so as to include the foot (and particularly in the case of a Pott's fracture) the fore-part of the foot is pushed up apparently under the delusion that dorsi-flexion of the fore-part of the foot is the equivalent of dorsi-flexion of the ankle. Few things can be more disastrous, and it is therefore very important to keep this fact in mind while performing the movements of dorsi-flexion and plantar flexion of the ankle by manipulation, and particularly when this precedes the application of a plaster splint. The whole of the fore-part of the foot must be left severely alone, and dorsi-flexion must be performed, with the knee well flexed to relax the tendo-Achillis (by moving the os calcis), and through it the astragalus, in the upward direction. Then, to perform the movement of plantar flexion the hand upon the dorsum of the foot should be so placed that the proximal side of the index finger rests upon the lower end of the front aspect of the tibia. The web between finger and thumb must fit accurately over the neck of the astragalus. If on examination the movement is not completely free, it is well to perform once more those movements which are not under voluntary control. While performing the movement of plantar flexion a small degree of lateral movement may be superimposed.

Traction

Unless full extension can be secured without a trace of strain, traction must not be applied as a mobilising force except with the knee flexed Short, therefore, of raising the thigh to the vertical and fixing the back of the thigh with a strap to the upper end of the couch, the only method by which traction can be laid upon the knee when extension is deficient is by the manipulation previously attributed to Marlin and which was described when considering the application of traction to the ankle and sub-astragaloid joints (See p 181) The first mobilising movement should be the application of traction by this method This calls for no further description The knee, is, however, one of the joints at which traction is relatively of small value

Antero-Posterior Movement

The antero-posterior movements of the tibia on the femur can only be performed when the knee is partly flexed and the movement does not begin to become appreciable until flexion has advanced to a considerable degree, this is in marked contrast to the lateral mobility which can be secured the moment flexion begins If now the knee is flexed until the sole of the foot in full plantar flexion can rest in comfort on the table, we shall find that this is the position which first allows a perceptible degree of antero-posterior movement Having secured this position the operator takes his seat upon the side of the couch so that the front part of the patient's foot rests underneath his thigh just distal to the ischial tuberosity (See Fig 269) There is no need for any great weight to rest upon the fore-part of the patient's foot, all that is required is to stabilise the position on the couch while the mobilising force is impressed on the upper end of the tibia with both hands These together then grasp the circumference of the upper end of the patient's leg, the fingers passing behind the calf, while the thumbs are abducted so as to rest vertically one on either side of the tibial tubercle The thenar eminences of the two hands are then placed on the two sides of the upper part of the shaft of the tibia in such a position that, when the two hands are pressed together, they will grip between them the anterior ridge of the

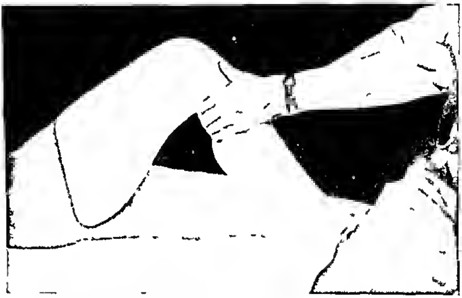

FIG 269 To show the grip for securing the antero posterior movement of the tibia on the femur This movement should be performed in all possible stages of flexion

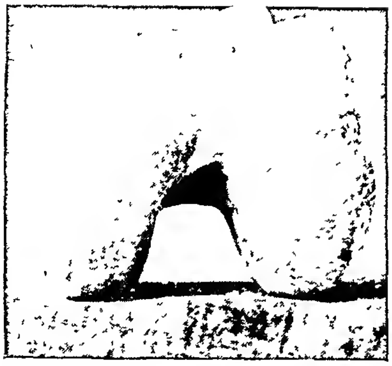

FIG 267 To show the unequal length and the difference in "setting" of the articular facets at the lower end of the femur Both are important factors in the rotation of the femoral condyles on the head of the tibia

femur. Of necessity, with the femoral origin of the lateral ligaments as centre and the line between these and their insertion below the knee as radius, the insertions must describe a circle, but the outline of the lower articular facets on the femur as seen from the side is in the form of an arc which is not the arc of a true circle (see Fig. 268), and it is this fact which allows a sufficient laxity in the lateral ligaments, once flexion begins, to render possible the lateral movements of adduction and abduction of the tibia on the femur. If now we study carefully the arc formed by the femoral articular surfaces in relationship to the origin and insertion of the lateral ligaments it will be seen that the lateral ligaments must be taut in full extension or full hyper-extension, and also when the knee is flexed to an angle of about 45 degrees with the thigh. There is a slight flattening of the articular surface near the front half of the articulation, and it is this degree of flattening, slight as it is, which allows the lateral play that can always be obtained in certain positions, even in a normal knee joint.

Movements Not Under Voluntary Control

When we come to the consideration of the movements which can be performed at this joint let it be said at once, and as emphatically as possible, that, if full extension of the knee joint cannot be obtained by the simple expedient of raising the heel with one hand from the couch with the patient in the recumbent position, then no attempt should ever be made to complete extension until all the other movements which are possible at the joint have been performed.

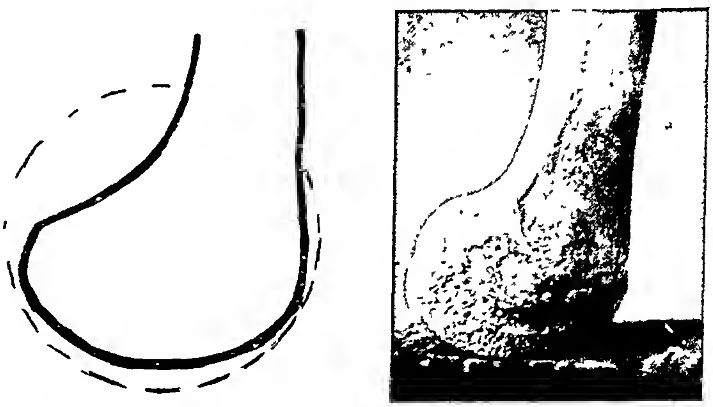

FIG 268 Lateral view of the internal femoral condyle showing that the contour is not that of a circle The diagram shows the contrast between the bony outline and that of a true circle

To test the extension, whether full or not, one hand raises the os calcis a few inches. The other hand, placed over the posterior surface of the lower end of the femur, rotates the hip outward, thus unlocking the rotation of the femur on the tibia. The joint is flexed by this hand for 10 to 15 degrees, the support is then withdrawn and the hand supporting the os calcis allows the knee to drop on to the couch while the thigh rotates inwards. If there is any trace of recoil, there is a pathological limit to extension ; if there is no recoil, extension is complete and the rotation of the two bones on one another has locked the joint in full extension.

shaft of the tibia The wrists are fully dorsi-flexed and fingers, wrist and fore-arm are held completely rigid while the elbows flex and extend as little as is compatible with the forward and backward flexion of the shoulder regions This acts as the mobilising force Even the shoulders may also be held completely rigid, and then the force is impressed by the swaying backwards and forwards of the trunk but usually the mobilising force consists of a combination of the two Having performed the movement once the knee is then flexed to a slightly more acute angle and the process is repeated, the mobility will then be found steadily to increase till the right angle is reached The range of movement is shown in Figs 270 and 271 After this point it slowly decreases again until it vanishes completely as full flexion is approached

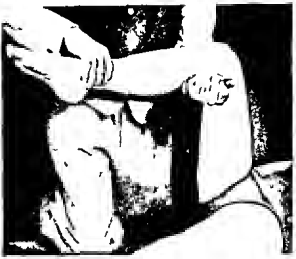

Fig 272 To show how the head of the tibia may be moved forward on the lower end of the femur in marked flexion of the knee the impressed force being exerted by the anterior aspect of the fore arm which is gripped between the posterior aspect of the patient's thigh and knee This shows the starting position

Having freed this movement throughout the full possible range of flexion i e from about 35 degrees of flexion till the tibia is vertical, the next movement is to lever the tibia forward on the femur when the knee has been bent to a yet greater extent In order to do this the thigh is placed in the vertical, with the knee bent to a right angle, the fore-arm of the stabilising hand is placed in the fold behind the knee, and the mobilising hand grasps the front of the leg bones just above the ankle (See Fig 272) The movement is performed by the mobilising hand increasing flexion so that the stabilising fore-arm is compressed between the back of the patient's thigh and the back of the calf (See Fig 273) At the same time the stabilising fore-arm may be drawn forward so as to direct the pressure directly at right angles to the long axis of the shafts of the leg bones If flexion is painful before the necessary degree of movement is secured the following technique may be impossible, but if the right angle degree of flexion can be reached painlessly, the thigh is flexed to the vertical and the knee to a right angle (See Fig 272) The stabilising hand grasps the tibia and fibula from in front just proximal to the malleoli, while the opposite fore-arm, the elbow being bent to a right angle, is placed in full supination in contact with the posterior

Fig 273 To show the end of the movement illustrated in Fig 272

FIG 270 To show the X-ray appearance when the tibia is pulled forward on the femur (*Cf* Figs 269 and 271)

FIG 271 To show the X-ray appearance when the tibia is pushed backwards on the femur The change in the relative positions of the bones, when comparing Figs 270 and 271, is best seen if the position of the spine of the tibia in relation to the condyles of the femur is noted

marked the maximum range of movement is reached when the back of the thigh and leg are still resting upon the couch. If now the stabilising hand dorsi-flexes the foot, the mobilising hand can carry the knee through a circular movement, clockwise and counter-clockwise. The diameter of the circle is fixed by the range of lateral movement allowed by the lateral ligaments. This movement is of particular service in increasing and maintaining mobility in cases of old-standing chronic arthritis of the knees, and often adds very materially to the patient's comfort, thus increasing functional activities to a material and valuable extent.

Movements Under Voluntary Control

These consist of flexion and extension, rotation of the tibia on the femur, or of the femur on the tibia, taking place when extension becomes complete.

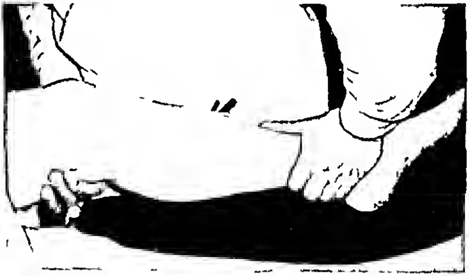

Fig. 290. To show the grips for performing the circular movement of the knee joint. Note the slight external rotation of the whole limb.

Flexion is the first movement to be performed and this is completed by flexing the thigh to the fullest extent possible over the abdomen before the mobilising hand carries the lower ends of the leg bones backwards towards the buttock. It must always be kept in mind that some individuals are completely incapable of sitting on their heels if the feet are fully dorsi-flexed, though most people are capable of doing so if the dorsum of the foot rests upon the ground with the ankles fully plantar flexed. So, too, in the standing position it will be found a comparatively easy matter to flex the knee sufficiently to bring the heel into contact with the gluteal region provided the hip is flexed upwards upon the abdomen; but, if the hip is extended, only a person with abnormal elasticity, almost of an acrobatic type, can bring the heel into contact with the gluteal region. Therefore it is essential, if flexion of the knee is to be complete, that the thigh should be flexed as far as possible.

It is well to repeat again that, if extension is incomplete as the result of a recent injury, it is always unwise to attempt to force the movement. If the previous manipulations have not rendered extension possible without force, the exercise of force will often do more harm than good. On the other hand, in cases of long-standing fixed flexion deformity, and particularly in those in which a certain amount of chronic arthritis of low grade has been

Fig 278 X-ray appearance of the relative positions of the bones when the tibia is rotated inwards on the femur

Fig 279 X-ray appearance of the relative positions of the bones when the tibia is rotated outwards on the femur The wide range of movement is best seen when comparing the positions of the head of the fibula in Figs 278 and 279

marked the maximum range of movement is reached when the back of the thigh and leg are still resting upon the couch If now the stabilising hand dorsi-flexes the foot the mobilising hand can carry the knee through a circular movement, clockwise and counter-clockwise The diameter of the circle is fixed by the range of lateral movement allowed by the lateral ligaments This movement is of particular service in increasing and maintaining mobility in cases of old-standing chronic arthritis of the knees and often adds very materially to the patient's comfort thus increasing functional activities to a material and valuable extent

Movements Under Voluntary Control

These consist of flexion and extension, rotation of the tibia on the femur or of the femur on the tibia, taking place when extension becomes complete

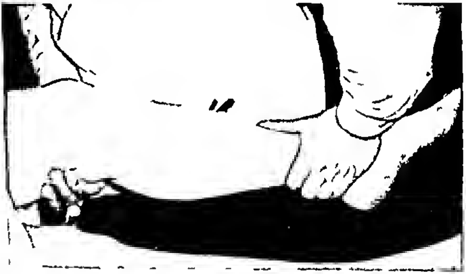

Fig 280 To show the grips for performing the circular movement of the knee joint Note the slight external rotation of the whole limb

Flexion is the first movement to be performed and this is completed by flexing the thigh to the fullest extent possible over the abdomen before the mobilising hand carries the lower ends of the leg bones backwards towards the buttock It must always be kept in mind that some individuals are completely incapable of sitting on their heels if the feet are fully dorsi-flexed, though most people are capable of doing so if the dorsum of the foot rests upon the ground with the ankles fully plantar flexed So, too, in the standing position it will be found a comparatively easy matter to flex the knee sufficiently to bring the heel into contact with the gluteal region provided the hip is flexed upwards upon the abdomen, but, if the hip is extended only a person with abnormal elasticity, almost of an acrobatic type can bring the heel into contact with the gluteal region Therefore it is essential, if flexion of the knee is to be complete that the thigh should be flexed as far as possible

It is well to repeat again that, if extension is incomplete as the result of a recent injury, it is always unwise to attempt to force the movement If the previous manipulations have not rendered extension possible without force, the exercise of force will often do more harm than good On the other hand, in cases of long-standing fixed flexion deformity, and particularly in those in which a certain amount of chronic arthritis of low grade has been

present for a long time, it is more than justifiable to restore extension as far as pathological changes in bone and cartilage allow, as otherwise the flexion deformity is liable to increase till the disability becomes very real and very severe. In this type of case extension may be limited by the formation of adhesions, and even if bone or cartilaginous deformity prevents the securing of full extension, it is always worth while to regain any degree of extension that has been lost owing to adhesions. On the other hand, simply from the manipulation point of view, it is imperative to stop directly we become conscious that the limitation has ceased to be due to adhesions and is now due to bony impediment. The extending force must therefore be under perfect control.

FIG 281 To show how the tibia is held in external rotation while passing from full flexion to full extension.

FIG 282 To show how the tibia is held in full internal rotation while passing from full flexion to full extension

If a marked degree of flexion deformity is present it is often wise to stop when the first dead-point has been passed, and to repeat the manipulation again at a later date when all reaction has passed off. There are times, however, when the bony impediment is such that a gross flexion deformity still persists ; then it is justifiable to overcome all resistance and place the knee as straight as possible, no matter what impediment has to be overcome. This, however, involves the subsequent fixing of the whole limb in plaster from as high up as possible towards the groin downwards to include the foot. The reaction, of course, may be severe, but the acute stage passes off very rapidly granted adequate fixation and the use of sufficient wool to act as a pressure pad and bandage—not less than two one pound rolls of cotton-wool (absorbent cotton in the U.S.A.) should be available, and this should be fluffed out with dry heat before it is applied. Next, a large hole is cut in the plaster over the knee so as to allow the knee to flex slightly through the hole. If the patient is then able, by voluntary contraction, to straighten the knee and so to move it through a few degrees, to and fro, the hole can be enlarged day by day to allow an increased range of movement. It is thus possible to regain for the patient approximately the

same degree of movement as was present at the start, but, as the movement is now from the straight through some 30 to 45 degrees of movement, the leg is rendered serviceable With the same degree of flexion starting from an angle of something like 45 degrees, the limb is practically useless Little if any increase in movement is gained as a rule, though it is justifiable to hope it may be while not encouraging the patient to expect it The objective is to render such range of movement as exists of service to the patient instead of being useless A relatively high heel often helps adequately if extension still remains slightly deficient

If however, there is no gross bony or cartilaginous impediment to extension, when the movements which are not under voluntary control have been completed, it is wise to ensure that the full range of movement has been restored In order to do this the mobilising hand grasps the heel of the patient from the inner side, the fore-arm rests up against the side of the foot, the knee is bent and the foot is held by the fore-arm in a position of full external rotation (See Fig 281) The thigh is then flexed well up on to the abdomen flexion is rendered complete, and then while the stabilising hand guides the knee with an outward or an inward pressure, as may appear desirable from what has gone before, the mobilising hand leads the foot down till the knee is fully extended, the hand placed upon the knee guiding it until a definite locking in full extension has taken place Now the grip is reversed, the fingers of the mobilising hand grasp the sole of the foot from the outer side while the thumb passes over the dorsum The leg is then rotated inwards on the femur and the movement from full flexion to full extension is repeated (See Fig 282)

It will be observed that while performing these movements, and while performing the movement of rotation of the tibia on the femur, it is wise that the finger and thumb of the stabilising hand should be placed one on each side of the patella ligament just above the top of the tibia This will prevent any dangerous movement of the semilunar cartilages in the front part of the joint

Movements of the Patella

Let it be said at once, and emphatically, that it is always completely unjustifiable to attempt to secure full flexion in any knee joint until we have secured absolute assurance that the patella is free to move throughout the normal range in all directions Only too often disregard of this precaution leads to fracture of the patella, this particularly applies after operation for fracture of the bone when flexion is not complete The temptation to restore the movement may be great, but, unless the complete range of normal mobility has been restored to the patella before the manipulation takes place, it is almost inevitable that re-fracture should occur

Movements Not Under Voluntary Control

Longitudinal Movements

These consist of downward movement and lateral movement in both

FIG 283 To show the grip for performing the downward movement of the patella on the femur The two index fingers are shown extended, as a superimposed photograph with the fingers flexed as described in the text made the picture too complicated The wide range of longitudinal movement is shown instead

directions. Contrary to a very common doctrine, the downward movement of the patella towards the tibia is definitely more important from a manipulative point of view than any of the other movements. In order to secure this the leg is placed as slack as possible on the couch; the first finger of the mobilising hand is flexed at the two distal joints and fully extended at the metacarpo-phalangeal joints. The thumb is then adducted as strongly as possible against the index with the distal joint hyper-extended. This leaves a V-shaped cavity between the palmar surface of the distal phalanx of the thumb and the side of the proximal phalanx of the first finger; this triangular space is then made to fit over the upper pole of the patella, and the hand is pressed down firmly towards the femur. Having pressed as far as possible vertically towards this bone, the hand guides the upper pole of the patella downwards towards the tubercle of the tibia. A similar grip with the other hand guides the lower pole, especially when the downward pressure of the first hand is relaxed. The mobilising force is largely trunk movement. The line chosen should be exactly that of the patellar ligament. (See Fig. 283.) It will, of course, be noted that even if a transverse fracture of the patella has taken place and an operation has been performed, then this movement is still entirely safe, as the mobilising foree tends to approximate the two surfaees at the site of fracture towards one another. Unless any aetive infeetive process is suspected within the subcrureal poueh, this movement may quite safely be performed with the utmost vigour provided it is not unduly painful. A yet more powerful grip is shown in Fig. 284, but now only the one hand is available to assist the return journey.

FIG 284 To show an alternative grip for mobilising the patella Here only the downward movement is shown, but the two lateral and the upward movements are no less important A similar grip is taken for movement in all directions (Cf Fig 285)

Lateral Movements

The limb, with the knee extended as far as may be, is first of all rolled round into internal rotation and is

Fig. 285. To show the grip for performing the lateral movement of the patella on the femur.

steadied in this position by the stabilising hand. The mobilising hand is then placed in full dorsi-flexion and the hollow formed by the prominent ends of the carpal arch is placed up against the lateral aspect of the bone. The mobilising force is then impressed by trunk movement by a forward thrust of the fore-arm, the direction of the force being directly at right angles to the long axis of the femur. (See Fig. 285.) The limb of the patient is then rolled round into external rotation, the operator walks round to the opposite side of the couch and the same movement is repeated with a corresponding grip. Again, unless very dense adhesions are present, the utmost force can be exerted without any risk whatever of doing harm. In the absence of infection the only risk is causing hæmorrhagic effusion and this is inconceivable unless the treatment is grossly abused.

Movement Under Voluntary Control

This consists of the movement of the patella in an upward direction, and, although it is limited to the normal elastic stretch of the patellar ligament, it is always worth while to ensure that the upward movement away from the tibial tubercle is as complete as the ligament will allow. A somewhat identical grip is taken as for moving the patella downwards; again, it is noticeable that, after transverse fracture, this movement tends to press the fractured surfaces together and therefore is entirely safe. The normal movement of the patella on the femur during the movements of flexion and extension requires no further comment, save that it must once more be emphasised that there is extreme danger in attempting to perform flexion of a knee joint even through small range until the mobility of the patella has been adequately restored.

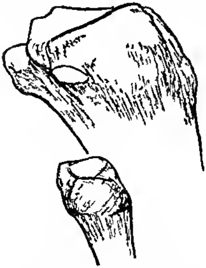

Fig. 286. To show the joint surfaces which articulate with one another at the upper ends of the tibia and fibula.

The Superior Tibio-Fibular Joint

Anatomical Considerations

There is one condition which causes pain and disability in the region of the knee joint that is very often entirely overlooked. The pain is often also referred to the ankle region, and indeed this is not infrequently the only complaint the patient will have; the trouble in the knee region may even be overlooked entirely. It has already been noted that there is no joint surface between the

FIG 283 To show the grip for performing the downward movement of the patella on the femur The two index fingers are shown extended, as a superimposed photograph with the fingers flexed as described in the text made the picture too complicated The wide range of longitudinal movement is shown instead

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FIG 284 To show an alternative grip for mobilising the patella Here only the downward movement is shown, but the two lateral and the upward movements are no less important A similar grip is taken for movement in all directions (Cf Fig 285)

Lateral Movements

The limb, with the knee extended as far as may be, is first of all rolled round into internal rotation and is

Fig. 285. To show the grip for performing the lateral movement of the patella on the femur

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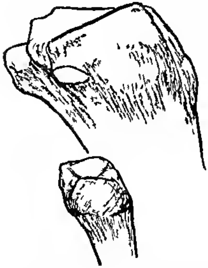

Fig. 286. To show the joint surfaces which articulate with one another at the upper ends of the tibia and fibula

The Superior Tibio-Fibular Joint
Anatomical Considerations

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FIG 284 To show an alternative grip for mobilising the patella Here only the downward movement is shown, but the two lateral and the upward movements are no less important A similar grip is taken for movement in all directions (*Cf.* Fig 285)

Lateral Movements

The limb, with the knee extended as far as may be, is first of all rolled round into internal rotation and is

between finger and thumb and press the bone backwards with a slight inclination inwards If this movement reproduces pain, we have a reasonable assurance that the symptom can be relieved by manipulation The technique is to flex the knee and to place the thumb of one hand as far up into the crease behind the knee as it will go The thenar eminence should then be placed in such a position that it will rest exactly behind the head of the fibula when flexion is complete (See Figs 287-289) The mobilising hand now grasps the foot with exactly the same grasp as that which was used when performing full extension from the position of full flexion, but this hand leads the knee and hip into flexion without exerting any externally rotating force, indeed, it should guide the movement of flexion, while assisting as far as possible the internal rotation of the tibia on the femur Now as flexion of the knee increases it will be found that the thenar eminence is being nipped between the back of the calf and the back of the patient's thigh The pressure is increased by further flexion of the knee as far as possible, and then both hands work in unison as mobilising hands The hand grasping the foot swings the tibia and fibula into external rotation, and the thenar eminence of the thumb behind the fibula is driven sharply forwards and slightly outwards, the incidence of the force being directly at right angles to the long axis of the fibula In this way the head of the bone can be slipped forward, and normal free and painless movement can be restored

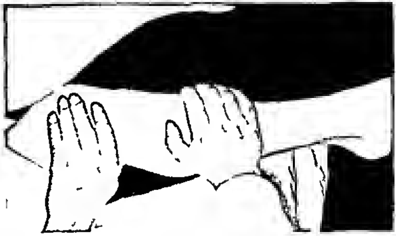

FIG 290 To show an alternative method for mobilising the superior tibio fibular joint

Sometimes it will suffice merely to "spring" the joint by pressing with the "heel" of the dorsi-flexed hand on the middle of the shaft, the pressure being exerted towards the tibia with a slight inclination forwards The patient lies on his side and the limb is placed in such a position that the inner sides of both knees and foot rest flat upon the couch (See Fig 290) The palm of one hand is placed over the middle of the shaft of the fibula, the wrist is fully dorsi-flexed so that the weight of the body can act as a mobilising force in bending the "spring," *i e* , the shaft of the bone, inwards At the same time with the other hand placed just below the head of the bone, with wrist dorsi-flexed and with the elbow and shoulder rigid, a forward mobilising force is exerted by trunk rotation At the same time, the thumb of the upper hand, which rests behind the head of the fibula, is driven forward by ulnar adduction of the hand This is an essential part of the mobilising force

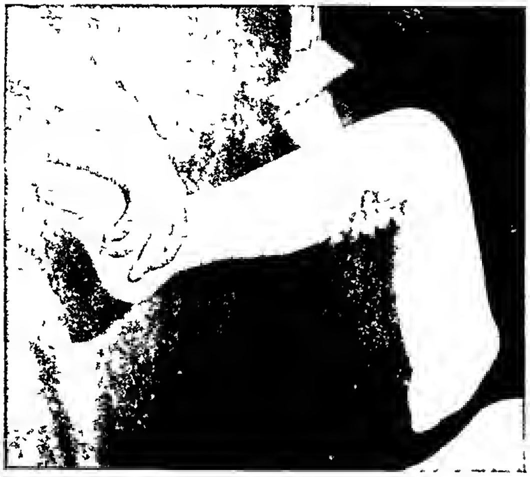

FIG 287 To show the grip for the manipulation of the superior tibio-fibular joint and how the impressed force is exerted by outward rotation of the tibia on the femur while pressing directly forwards with the thenar eminence that is grasped between the posterior surfaces of thigh and calf This shows the starting position (*Cf* Figs 288 and 289)

lower ends of the tibia and fibula; they are joined together by a massive interosseous ligament. At the upper end, however, there is a joint with a definite cartilaginous surface on both bones and a perfectly normal synovial cavity. (See Fig. 286.) The conclusion is inevitable that the head of the fibula is free to move upon the corresponding surface of the tibia. When we examine the "set" of this joint we find that it is placed towards the back part of the tibia and runs obliquely from behind forwards and outwards; it must, therefore, of necessity be very difficult for the head of the fibula to slip forward to any noticeable extent upon the tibia, but there is nothing so far as the bony configuration is concerned to prevent it slipping backwards. It is not an uncommon event for this to happen and for the fibula to bind upon the surface of the tibia with a small degree of backward displacement.

Movements Not Under Voluntary Control

There are no movements at this joint that are under voluntary control; the fibula moves on the tibia and not vice versa, and then only as the result of the transmission of force from the ankle region.

When on close examination the patient complains of pain near the outer side of the knee and the examination reveals no demonstrable lesion in knee, hip or ilio-tibial band, it is always worth while to take the head of the fibula

FIG. 288 To show the second stage in the manipulation of the superior tibio-fibular joint The position is now "set" for the manipulating force to be exerted (*Cf* Fig 289)

FIG 289 To show the final stage in the manipulation of the superior tibio-fibular joint As the right hand rotates the leg outwards upon the thigh, the left thenar eminence presses the head of the fibula forwards and outwards

is almost a repetition of the story of the hallux rigidus first a very trifling limitation is present Very occasionally during normal movement the pathological limit of movement is reached this causes a mild inflammatory condition within the joint which, so far as the patient is concerned is too trivial to attract more than momentary attention Gradually the pathological condition increases as the result of these recurrences of mild inflammation and this involves a continuous increase in the frequency of attacks of irritation within the joint Still the process is so gradual that it is usually not until severe damage has been done that the patient will seek advice then, of course, only alleviation can be secured—cure is impossible and relapse sooner or later is almost inevitable

More terrible disaster can follow the injudicious manipulation of a hip joint than the manipulation of almost any other joint in the body With long-standing disability it not infrequently happens that a definite degree of atrophy of bone is present in the neck of the femur and in this event the application of force is liable to lead to fracture of the neck of the bone It is infinitely better to leave the patient alone than to run any risk of this calamity It is easier to imagine than to describe the feelings of the man, who found with joy that a wide degree of movement had been restored to his patient as the result of manipulating both hips which had suffered from severe limitation, when he discovered subsequently on X-ray examination that the immobility of the head of the bone on both sides was unaltered, and that movement had taken place as a result of fracture of the neck of the femur on both sides Not only am I informed that this actual catastrophe has occurred, but that fracture of the neck on one side has been sufficiently frequent to justify the supposition that abuse of the treatment is all too common No one should ever manipulate a hip joint without considering this risk, and avoiding it by meticulous care and attention to technique It cannot be too often insisted on that, if limitation of movement is marked, it is not only futile but dangerous to attempt to secure full restoration

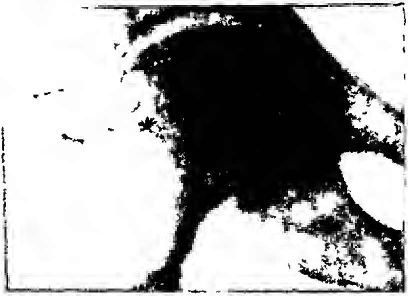

FIG 292 To show a degree of arthritis of the hip which may be considered as offering an excellent prognosis as the result of manipulation All pain and discomfort was relieved and full function restored except for a minute trace of internal rotation

There are, however, certain types of advanced arthritis of the hip joint where treatment by manipulation may be of very considerable service

CHAPTER XVII

THE HIP JOINT

Anatomical Considerations

When dealing with the anatomical considerations of the shoulder joint attention was drawn to the essential differences between the shoulder joint and the hip joint. It was then pointed out that not only is the circular head of the femur enclosed through a large part of its circumference in the circular bowl of the acetabulum, thus effectively preventing all gliding movements (see Fig. 291), but that in addition the ligamentum teres is attached to the centre of the head of the bone and to the centre of the acetabulum. (It should be noted that the word "centre" is used approximately in both instances.) As, therefore, little or no gliding movement can take place

Fig 291 (After Piersol) The inner wall of the hip joint socket has been cut away The photograph shows the more familiar aspect of the head of the femur

between the head of the femur and the acetabulum, it necessarily follows that there is only one movement which is not under voluntary control, and that is traction. Yet there can be no doubt that one of the most satisfactory joints to manipulate under suitable circumstances is the hip joint, and it is most unfortunate that patients very often fail to solicit aid until the condition is so far advanced that manipulation is either futile or can only produce a relatively slight amelioration. If only patients would report for treatment directly the first trace of impediment to movement is noted, it should be possible to restore the full range of movement, and then the chronic irritation of the joint on movement would cease, and in very many cases at least the advance towards gross disability might be permanently checked. The story

Droitwich There is, however, one essential for the success of the Droitwich treatment, and that is that the patient should carry out the instructions of the medical man in charge with intelligent and conscientious exactness An excess of zeal may even undo the benefit bestowed by manipulation

FIG 294 To show a degree of arthritis of the hip which offers a very doubtful prognosis Although the joint space above is so narrow yet the acetabulum is so shaped that the head of the femur can be pulled downwards so as to create an adequate space to allow marked restoration of movement In this type of case the patient is well advised to undergo a short course of treatment say once in every four to six months to prevent relapse (This proved to be a very successful case)

Movement Not Under Voluntary Control

If it is decided to manipulate the first thing is to apply traction The heel is grasped in the palm of one hand with the thenar eminence grasping one side and the palmar surfaces of the fingers the other side the back of the heel resting in the palm (See Fig 295) The other hand is then placed over the dorsum of the foot, passing transversely from within outwards and securing the grip as near as possible to the ankle joint The external rotation must be respected and this accounts for the alteration of the grip from that shown in Fig 256, p 180, when applying traction to the sub-astragaloid joint Unless the external rotation is maintained the joint is not in a position of rest and so the head of the femur is not at liberty to travel downwards, and the separation of the weight-bearing surfaces is not secured to the best advantage A roller towel is then placed around the groin on the opposite side and the hip is abducted as far as it will go The assistant then secures the two ends of the towel and arranges it in a line parallel with the long axis of the femur on the side to which the traction is to be applied Then, when all is ready the body weight of the operator acts

FIG 295 To show the method of applying traction to a hip joint Note the counter pull of the towel placed round the opposite groin A rotatory movement may be applied to the whole limb during the application of the traction

this particularly applies to those cases in which the acetabulum has "travelled" and in which, therefore, it is possible to pull the head of the femur downwards in the acetabulum. (See. Fig. 292.) There is another type where manipulation is well-nigh useless. It is true that the manipulator may secure an increase of range which will cause him great satisfaction, but the patient will not feel equal satisfaction when he finds that the amount gained by way of function does not compensate for the time spent and for the discomfort of an anæsthetic. This is the type where the head of the femur has definitely increased in size while the acetabulum has not done so except for lipping with osteophytic outgrowths. (See Fig. 293.) Between these two there are a large number of different types, one of which is shown in Fig. 294, in which every conceivable variety of prognosis may be given, from very favourable to utterly useless. In many cases of advanced type the verdict should be very doubtful, and in this event it is wiser to err on the side of caution and to refuse to manipulate. There is, however, one thing to be said, and that is that refusal to manipulate is not synonymous with saying that nothing can be done.

FIG 293 To show a degree of arthritis of the hip in which manipulation should not be attempted Not only would little or no good be derived from it the potentialities for doing far more harm than good are very real

Active Movements

Movements in the Brine Bath at Droitwich will often restore mobility to an extent that manipulation would inevitable fail to restore, and indeed it is well to consider Droitwich as the Mecca for all patients suffering from complaints of the hip joints. It is a wise practice, no matter how good the prognosis for manipulation may be or how satisfactory the manipulation has proved in the event, to send the patient to Droitwich in order to maintain mobility if it has been restored to perfection, or to increase the degree of mobility if perfection has not been obtained. This much may safely be said, that there is no alternative to Droitwich, unless possibly corresponding treatment can be secured in the Dead Sea or Salt Lake City. In Budapest and Pistani we may have a second best, but it is a very bad second to

the movement of the affected limb towards the couch Then, when the whole of the limb on the affected side is flat and fully supported by the couch, the hand on the front of the thigh becomes the stabilising hand fixing the back of the thigh to the couch, and that over the flexed knee becomes the mobilising hand By increasing flexion on the sound side we increase extension on the affected side owing to rotation of the pelvis on the femur Extension should not, however, follow directly on flexion, and the movements should be taken in the order indicated below and extension can often be performed more effectively in the prone position (*vide infra*)

Fig 297 To show the most favourable position for performing rotation of the hip joint This shows the grip for external rotation but the mobilising hand is here shown in the position taken to raise the limb Before the mobilising movement it is withdrawn from under the knee and is placed over the inner aspect of the thigh

Rotation

Having coaxed the movement of flexion to the fullest extent, the rotation movements should be taken next With the patient still recumbent, the thigh is flexed till it reaches the vertical, with the knee flexed to a right angle The mobilising hand is passed under the leg and the palm of the hand is placed against the inner side of the thigh as near the middle as is compatible with the position of the rest of the limb The back of the leg rests upon the operator's fore-arm and the outer side of the arm rests upon the outer side of the leg somewhere about its middle (See Fig 297) The stabilising hand guides the movement, after having been passed over the front of the thigh so as to attain the inner aspect above the knee joint In this position the thigh can be led round so as to carry the foot over the opposite thigh Internal rotation is performed by reversing the position The mobilising hand is passed from within outwards under the patient's leg, and the fore-arm is fully pronated so that the palmar surface of the fingers may rest upon the outer side of the thigh (See Fig 298) As little as possible of both these movements should be imparted by

Fig 298 To show the alteration in grip when we wish to pass from performing external rotation of the hip joint (see Fig 297) to internal rotation Note the rotation of the trunk of the operator In Fig 297 the chest is facing towards the patient's head in Fig 298 it is nearly facing towards the patient's foot where it rests upon the couch

as the extending force. As traction is more and more increased the body of the operator sways slowly from side to side so as slightly to increase the abduction if possible. The duration of the application of the traction is limited only by the question of fatigue on the part of those engaged in the manipulation. As there is no leverage the utmost force can be expended in safety, except as regards the movement of abduction. It is true that the fixation of the pelvis except in one position is not absolutely rigid, but even so it is wise not to strain too much towards securing the abduction.

Movements Under Voluntary Control

Flexion

The first movement to secure, after traction has been applied, is flexion. Both knees are bent until the soles of the feet rest upon the couch. The hip that we are to manipulate is then flexed up on to the abdomen as far as it will go. The patient grasps the front of the tibia with both hands and the stabilising hand reinforces this grip. The mobilising hand is then passed under the knee of the unaffected side in the manner shown in Fig. 297, and the knee is straightened. The limb is then lowered towards the couch slowly as far as it will go. When the limit of movement is reached the mobilising hand is withdrawn from underneath the leg and is placed upon the upper surface over the lower third of the unaffected femur. (See Fig. 296.) The mobilising force is now exerted by pressing the thigh down towards the couch, rotating the pelvis with it. In this way the acetabulum of the stiffened joint is rotated backwards on the femoral head—a far safer procedure than rotating the head forwards on the fixed acetabulum.

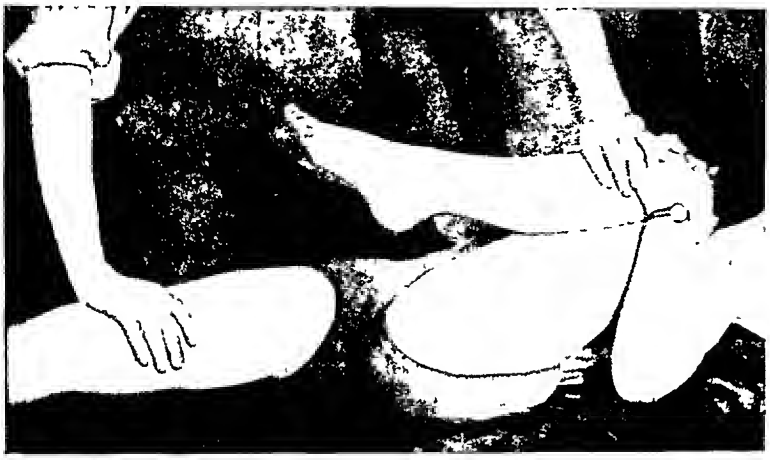

Fig 296 To show the method of performing flexion of the hip in the lying position

Extension

To secure extension in this position the procedure is reversed: on the sound side the hip is flexed over the abdomen and is held there while the femur of the stiffened side is lowered slowly towards the couch with the knee extended. When movement ceases, the hand which should rest on the anterior aspect of the affected thigh slowly presses the thigh downwards towards the couch, while the hand which rests over the flexed limb allows the hip of the unaffected side to extend as little as may be compatible with

deformity is too great to allow the patient to place the front of the thigh flat upon the couch without undue strain; if this is so, then any attempt to perform the movement in this position can only be regarded as extremely dangerous. Again it will be found that a wider range of movement will be secured if the thigh is slightly abducted. If the prone position is difficult to attain, it is wise to treat the patient on the back in the manner described already (see page 206). Finally the grip that was used for performing the rotation is again applied, the hip is led upwards into as full flexion as is possible, and full inward and outward rotation are performed alternately as the limb is led out into extension towards the couch.

It will, no doubt, be realised from this description and from examination of the illustrations that a very considerable amount of leverage is employed practically throughout the whole of these manipulations. At the same time the impressed force which has to perform them has the leverage reduced as far as possible and must be under perfect control. It has been pointed out already that one of the cardinal rules of manipulation of a joint is to "take up the slack" and then push or pull; when manipulating a hip (more perhaps than any other joint in the body unless it be the elbow), the utmost care must be taken to "take up the slack" to the full before impressing the mobilising force. Then with this force under perfect control and applied so as to gain at one time only the most minute amount of increase in the range of movement, little or no harm can be done. This much, however, must be said: first, that the manipulation is a long one and if any definite gain in the range of movement is secured in any one position, it means, of necessity, that all other movements must be repeated, as an increase in the range in one direction may very easily lead to an increase in range in one or more of the other directions. If an attempt is being made to perform the manipulation under an anæsthetic, it is essential that the anæsthesia should be profound. Unless muscular relaxation is quite complete, not only will the risk of fracture of the neck of the femur be increased materially, but the chance of being able to secure an increased range of movement without the application of utterly unjustifiable force is negligible.

With regard to the after-treatment, it is wise to repeat every manipulation that was performed under the anæsthetic the next day, coaxing the movements with massage, but ceasing directly anything more than the faintest discomfort is felt. In particular, massage will help to allay the pain and stiffness in the adductor muscles. There is no reason why the patient should not be allowed to move as freely as he likes for himself, and if possible he should be encouraged to get into a hot bath in which he should move about as freely as possible. It is very unwise, however, to allow the patient to walk more than a few steps, and this prohibition should continue usually for four or five days. It is almost inevitable that a certain amount of irritation will have been set up within the joint, and to allow the joint to serve the weight-bearing function until this inflammatory condition has died down completely is again simply courting subsequent disaster. Indeed, it is often

the shoulder; the main part of the movement should depend on the rotation of the operator's trunk.

Abduction

Having freed these two movements, an attempt should be made to increase abduction. The leg is carried over the front of the opposite thigh, the outer side of the leg just below the external malleolus resting upon the surface of the thigh on the sound side as high up as it can be induced to go. An attempt is then made to drop the thigh so that the outer side shall be near the surface of the couch, and it will sometimes be found that the wisest way to impress the manipulating force is to apply firm massage with the flat of the hand transversely to the adductor longus towards the middle of the muscle. Long leverage is dangerous.

Fig 299 To show the grip for performing extension of the hip in the prone position

Adduction

This movement can only be administered by carrying the thigh of the affected side inwards either in front of the sound side or behind it or both. Whether it is possible to carry it behind depends on the patient's ability to assume the prone-lying position. (*Cf.* Fig. 299. the only difference being that the mobilising hand rests on the outer side of the thigh.) The main mobilising force is trunk rotation. With the patient recumbent, adduction can be performed in the position shown in Fig. 296, p. 206, but it is very clumsy. The position shown in Fig. 297 is much to be preferred and has the great advantage that the mobilising force can be impressed at so many different degrees of hip flexion. The mobilising force is mainly trunk movement.

Extension

Extension can be performed in one of two positions. If the degree of fixed flexion deformity is not too great it is well to place the patient on his face. flex the knee to a right angle and pass the fingers of the mobilising hand underneath the front of the patient's thigh a little above the knee and between it and the couch. (See Fig. 299.) The front of the patient's leg then rests against the operator's fore-arm while the stabilising hand is placed over the ischial tuberosity. This hand must fix the pelvis firmly on to the couch, otherwise the extension of the hip backwards may inflict a severe rotation—or torsion—strain on the sacro-iliac joint. It should be noted that a wider range of extension will be secured if the thigh is slightly abducted than if an attempt is made to perform the movement with the thigh parallel to the long axis of the body. Often, however, the flexion

deformity is too great to allow the patient to place the front of the thigh flat upon the couch without undue strain; if this is so, then any attempt to perform the movement in this position can only be regarded as extremely dangerous. Again it will be found that a wider range of movement will be secured if the thigh is slightly abducted. If the prone position is difficult to attain, it is wise to treat the patient on the back in the manner described already (see page 206). Finally the grip that was used for performing the rotation is again applied, the hip is led upwards into as full flexion as is possible, and full inward and outward rotation are performed alternately as the limb is led out into extension towards the couch.

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one of the difficulties in the after-treatment of these cases when the manipulation has been successful, that the patient, feeling better as far as the joint is concerned, and delighted with the degree of the increase in the range of movement, finds it hard, having been able to walk relatively freely with the decreased range during the period of disability, to understand the necessity for rest from weight-bearing for several days after manipulation. Still, the only wise and sensible course is to rest for the prescribed period, and the subsequent increase in the range of movement from day to day will usually compensate the patient for the enforced inactivity.

It is exactly the same story on arrival at Droitwich. On entering into the "swim" a wider and more free range of movement is at once noted, and the patient is delighted with the freedom of the movement and the lack of exertion with which it can be performed. One, if not the main object of the treatment in the "swim" is to restore the elasticity that has been lost after months and perhaps even years of loss of function so far as mobility is concerned. The elasticity can only be restored by very gradual stages, and, as has been pointed out already, not only does function beget function and movement beget movement, but movement also will beget elasticity. It cannot, however, do it quickly; and although manipulation can be used to restore elasticity in the fascial planes, the benefit secured is in no way comparable with that secured by the patient's own efforts. Adhesions can be broken down by manipulation, but any severe attempt to stretch elastic tissue that has lost its elasticity can only end in one of two things, rupture or strain. Either, if untreated, is fatal to the recovery of function. A certain amount of strain is inevitable if movement that has long been lost is to be restored; anything beyond a very transitory feeling of stiffness, which passes off almost immediately when movement ceases, means that too much has been attempted. The great temptation to do too much is, of course, during the earlier days, as the restoration of elasticity proceeds by a geometrical rather than arithmetical progression. If, however, definite irritation is inflicted by an overdose of movement, it is essential to rest rather than to irritate further; it is for this reason that the patient is invariably asked to rest after exercise in the "swim" for a sufficient time to allow all trace of irritation to subside. The fact remains, however, that both in manipulation and in the after-treatment one of the most difficult of all decisions to make is the "spacing" of rest and movement. No harm can come of movement that is painless, or indeed of movement that causes discomfort, or even pain, provided that all trace of either has disappeared within half-an-hour of placing the part at rest. (See also p. 48 concerning under-water treatment.)

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